July 2001 Vol. 25 No. 7

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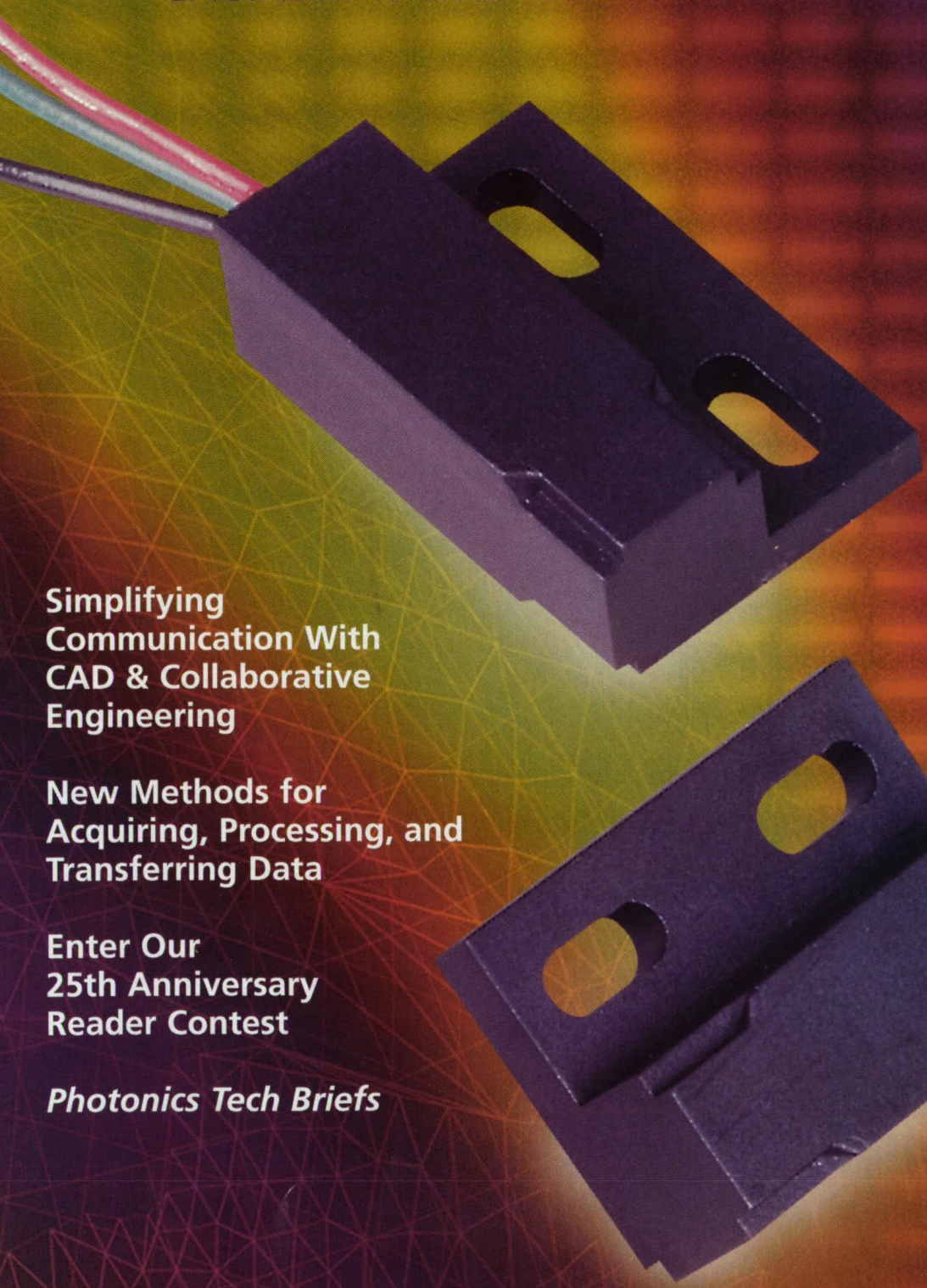

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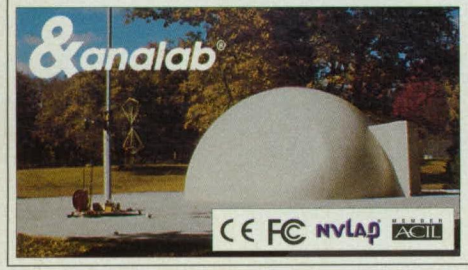

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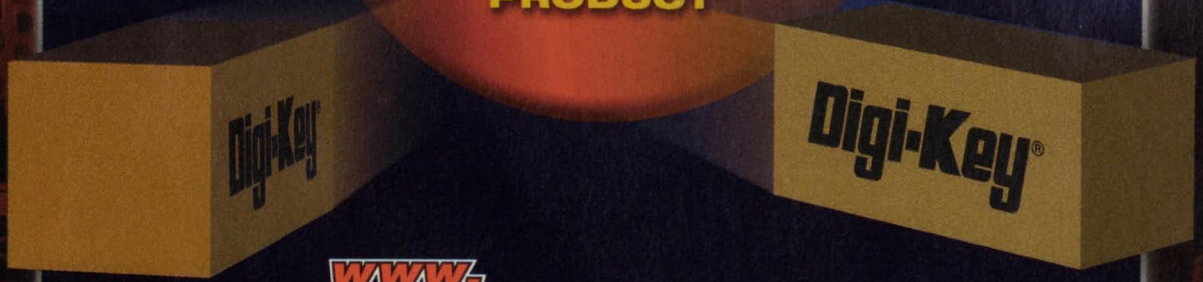

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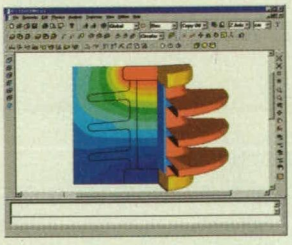

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Anatomy of ALGOR's New Interface
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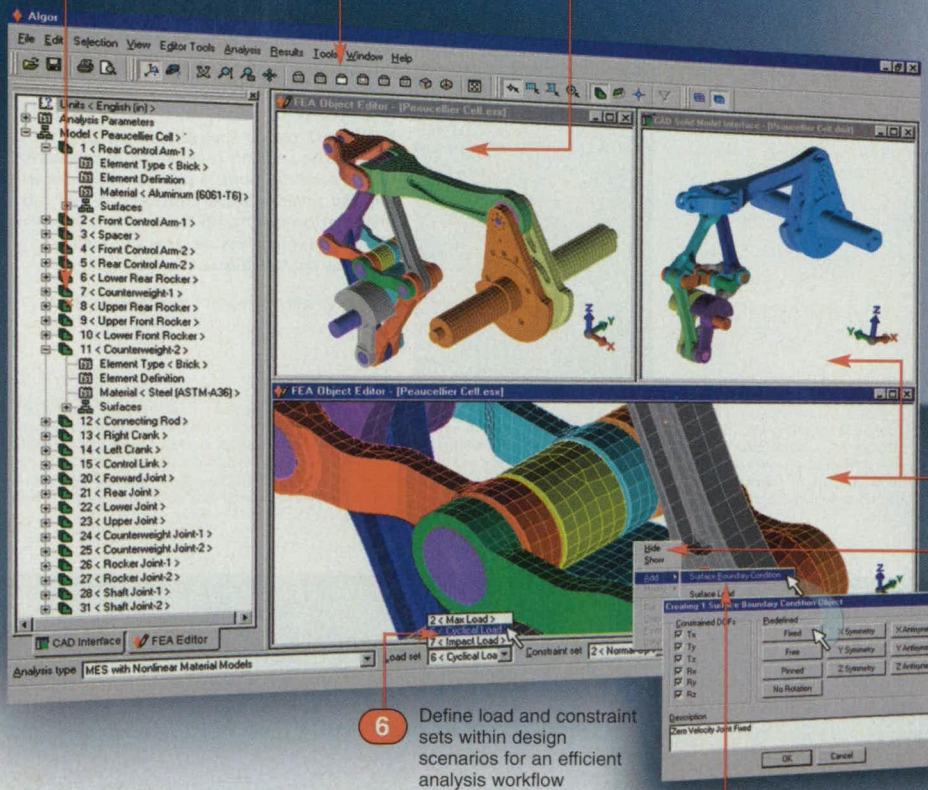
1. Built-in intelligence graphically indicates the need for additional data input
2. Docking toolbars for quick access to the most common options
3. Shortcut keyboard and mouse controls for dynamic viewing options



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4. Multiple view windows for any model version
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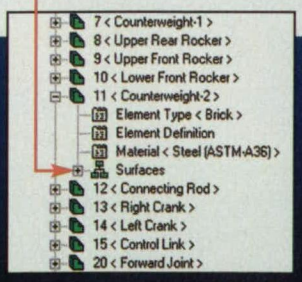
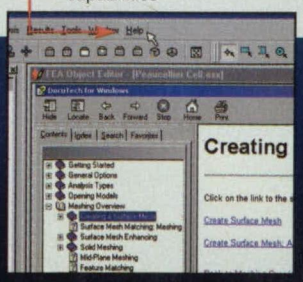
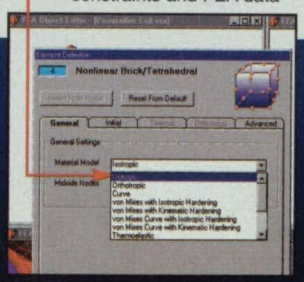
8. Tree view of model parts and associated FEA data



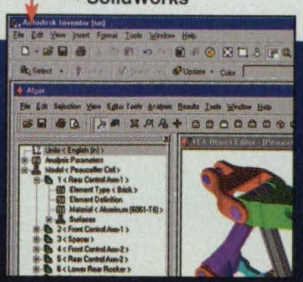
9. HTML compiled help with robust indexing and search capabilities



10. Windows-native input screens for all loads, constraints and FEA data



11.



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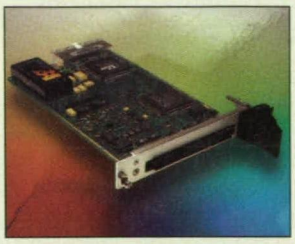
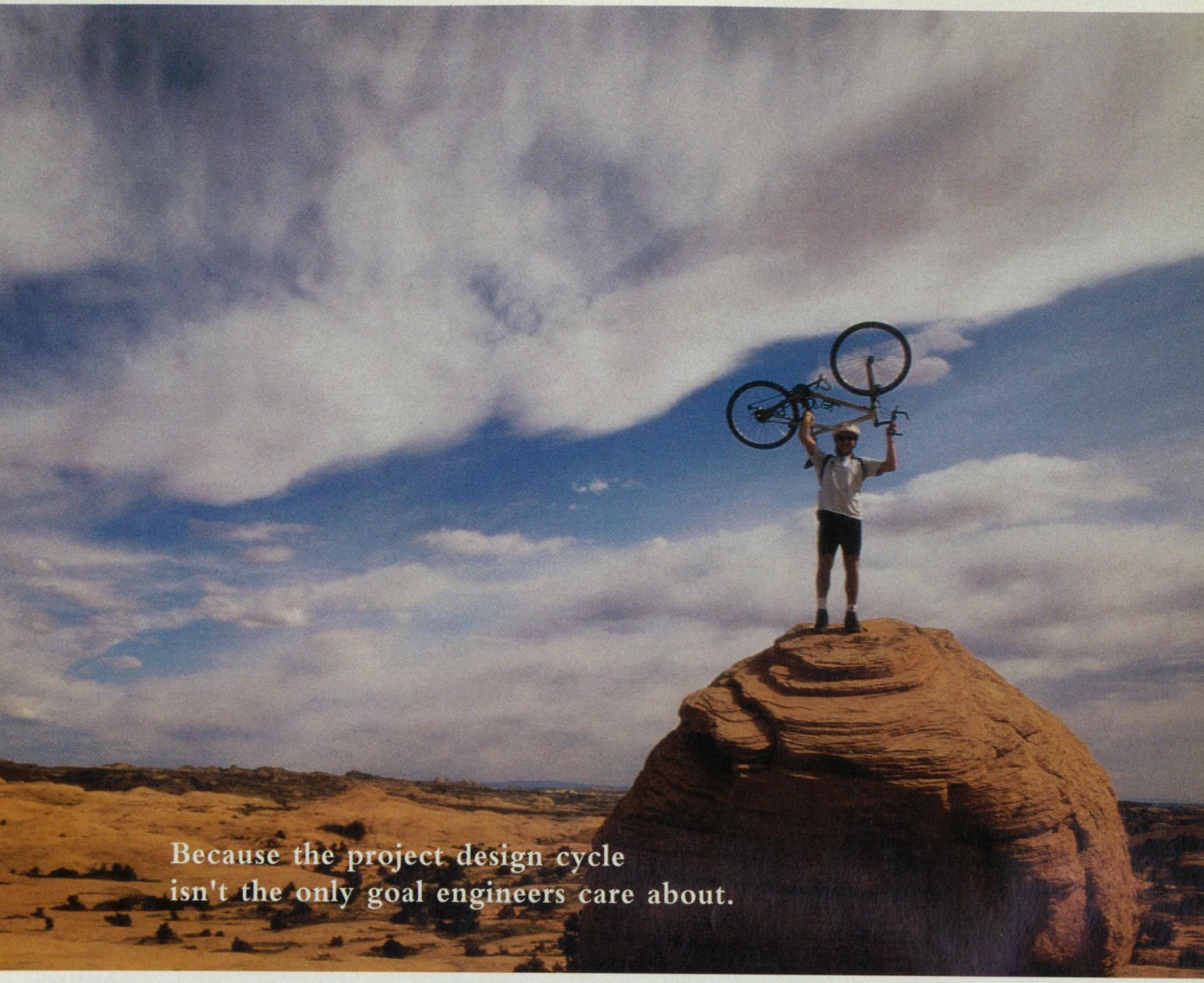


ON THE COVER

The MP1021 Series solid-state magnetic proximity sensor from Cherry Electrical Products of Pleasant Prairie, WI, is a digital Hall effect sensor that allows the user to specify the sensing face. Electronics internal to the sensing module provide noise filtering and reverse battery protection. For more information on the MP1021 — and to learn about other innovative new products — see New on the Market on page 61.

(Image courtesy of Cherry Electrical Products)



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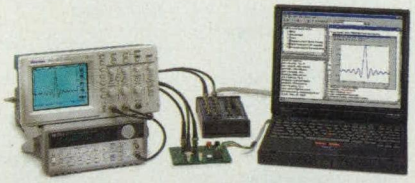

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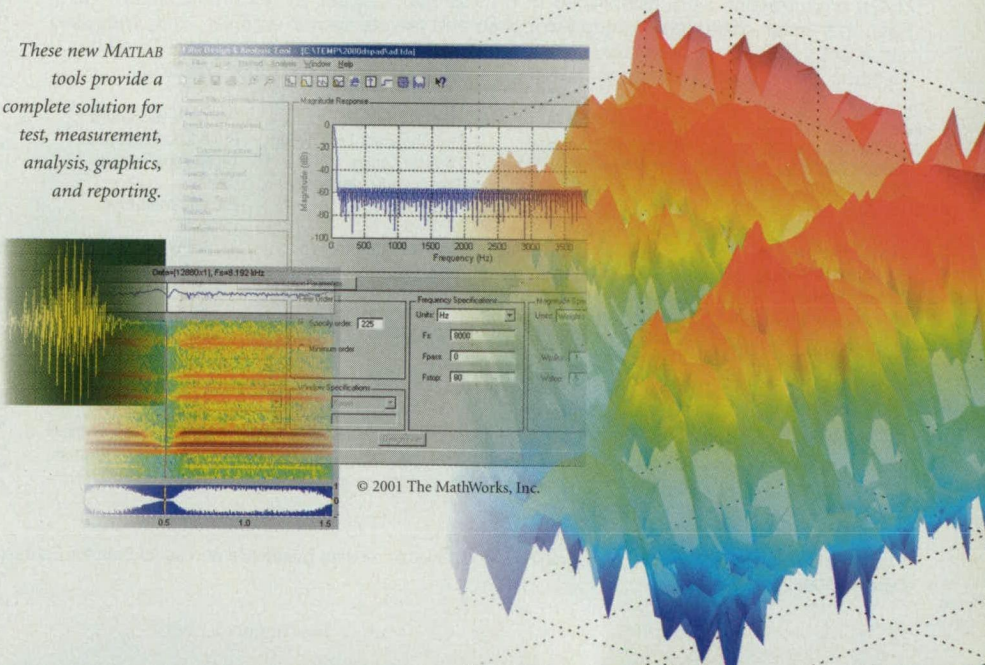

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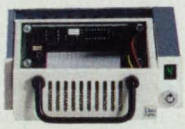

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For More Information Circle No. 523

Reader Forum

Reader Forum is dedicated to the thoughts, concerns, questions, and comments of our readers. If you have a comment, a question regarding a technical problem, or an answer to a previously published question, post your letter to Reader Forum on-line at **www.nasatech.com,** or send to: Editor, *NASA Tech Briefs*, 317 Madison Ave., New York, NY 10017; Fax: 212-986-7864. Please include your name, company (if applicable), address, and e-mail address or phone number.

I am designing and prototyping an instrument to scare birds from airplane landing strips and hangars, as well as from agricultural fields and orchards. I am completely in the dark regarding the ornithology involved. For example, what frequency of sound is enough to cause the birds to fly away from the source of the sound? Also, I'd be interested to know the frequency of sound that can disturb rodents such as squirrels, rats, and mice. I appreciate any assistance.

John C. Marchesini
MaGiCo Electronic Engineering
662-335-2014

Technologies Wanted

Periodically in Reader Forum, we feature abstracts of Demand-Pull Technology Transfer projects. These projects identify technology needs within an industry segment — such as Assistive Technology — and find solutions to meet those needs. The Rehabilitation Engineering Research Center on Technology Transfer, in partnership with the Rehabilitation Research Center on Hearing Enhancement, has developed the Hearing Enhancement Project to identify market needs like those described below that represent significant business opportunities. For more details on the project, or to submit technology solutions, visit the project web site at: **http://cosmos.buffalo.edu/hearing.**

Earmolds

Hearing aids, high-quality noise protection, and some assistive listening devices (ALDs) require precision earmolds, which couple the hearing aid to the user's ear, channel sound from the hearing aid through the ear canal to the eardrum, and help secure the device in place. The challenge is to provide a secure fit without making the device so tight that it becomes uncomfortable. The optimal measurement system will use advanced techniques to produce an accurate mathematical representation of the ear canal that takes into account changes in canal geometry caused by motion and environment. This representation will be interpreted by automated fabrication systems. Improved earmold materials must be comfortable and non-irritating to the wearer, and easily cleaned and maintained. The ideal material must not harden or shrink over time.

Assistive Listening Systems

Assistive Listening Systems (ALS) bring a remote, essentially noise-free sound signal directly to the hearing-impaired listener across the intervening reverberant and noise-filled acoustic space. These systems primarily serve a hearing-impaired population, but they are also used for high-quality sound amplification and enhancement in multiple environments. The biggest need is for a system that integrates IR, inductive loop (IL), and FM systems so that one receiver can operate with all three transmission modes. An IR system should use a multi-path or signal path approach to isolate the speaker(s) and listener(s). Low power and "smart" diodes that adjust power in response to the environment would be an improvement. The most common inductive loop receiver is the hearing aid telecoil. One issue with current IL systems is the need to install significant supporting infrastructure. Future loop systems need to be made easier to install and should not require changes to the walls, ceilings, and floors of buildings. The IL amplifiers should adjust for field strength and have a tuning capacity.

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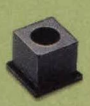


new ground as well. After all, making things stronger, faster, lighter, and subsequently, more efficient is what Vespel® Forward Engineering is all about. All things considered, there's never been a better time to think Vespel® Parts & Shapes early on in the design process. An idea more and more engineers are waking up to. For more information on what our expanded line of material solutions can do for you, go to www.dupont.com/vespel or call 1-800-972-7252. If you can dream it, we can make it.

NASA Patents

Over the past three decades, NASA has granted more than 1000 patent licenses in virtually every area of technology. The agency has a portfolio of 3000 patents and pending applications available now for license by businesses and individuals, including these recently patented inventions:

Method and Apparatus for the Portable Identification of Material Thickness and Defects Using Spatially Controlled Heat Application

(U.S. Patent No. 6,000,844)

Inventors: K. Elliott Cramer and William P. Winfree, Langley Research Center

An apparatus for the nondestructive identification of defects in structures is disclosed in this patent. It comprises a heat source and a thermal imager that move at a constant speed past a test surface of a structure. The thermal imager is offset at a predetermined distance from the heat source, which induces a constant surface temperature. The imager follows the heat source and produces a video image of the thermal characteristics of the test surface. Material defects produce deviations from the constant surface temperature that move at the inverse of the constant speed.

Photonic Switching Devices Using Light Bullets

(U.S. Patent No. 5,963,683)

Inventor: Peter M. Goorjian, Ames Research Center

The invention describes a unique, ultrafast, all-optical switching device made with readily available, relatively inexpensive, highly nonlinear optical materials, including optical glasses, semiconductor crystals, and/or multiple quantum well semiconductor materials. These materials have a sufficiently negative group velocity dispersion and high nonlinear index of refraction to support stable light bullets, thus preventing the degeneration of the pulses due to dispersion and diffraction at the front and back of the pulses. The light bullets counterpropagate through, and interact within, the waveguide to selectively change each other's directions of propagation into predetermined channels. In one embodiment, the switch utilizes a rectangular planar slab waveguide, and further includes two central channels and other channels for guiding the light bullets into and out of the waveguide.

Ultrasonic Bolt Gage

(U.S. Patent No. 5,970,798)

Inventors: Stuart M. Gleman and Geoffrey K. Rowe, Kennedy Space Center

Reliable and accurate bolt tension gages are an essential tool at the Kennedy Space Center to determine the amount of preload in critical bolts and studs located in both ground support equipment and flight hardware. Existing commercial gages perform adequately in most cases, but can produce unacceptable errors and uncertainties when doing tension measurement in some configurations of flight hardware. This team has devised an ultrasonic bolt gage comprising an ultrasonic transducer for coupling to a bolt, transmitting ultrasonic signals through the bolt, and providing echo waveform output signals. The processor provides analysis outputs indicating a tension applied to the bolt using both cross-correlation and feature recognition analysis.

Ferroelectric Fluid Flow Control Valve

(U.S. Patent No. 5,961,096)

Inventors: Antony Jalink, Jr., Richard F. Hellbaum, and Wayne W. Rohrbach, Langley Research Center

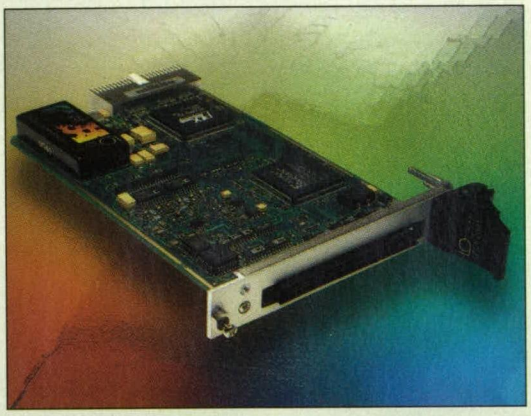
A "check valve" allows unimpeded passage of fluid in a flow in one direction and no passage of the fluid in the opposite direction. These passive valves require the action of the reversal of fluid flow to activate the valving action, and this need can lead to an undesirable amount of resistance against the fluid flow. This is lost effort that must be delivered by the pump. The present invention provides an active valve that is controlled and driven by external electrical actuation. The valve provides improved passage in the direction of the flow and positive closure in the direction against the flow. Application of an electric voltage to the ferroelectric actuator causes an electrical field between its faces, and in response the shape of the actuator changes.

For more information on the inventions described here, contact the appropriate NASA Field Center's Commercial Technology Office. See page 12 for a list of office contacts.

UpFront

PRODUCT OF THE MONTH

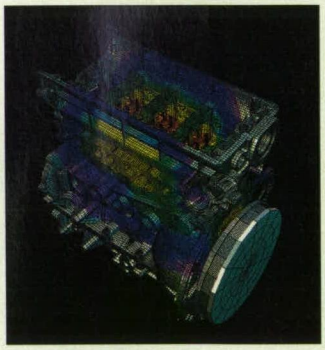
The DaqBoard/2000c™ series of CompactPCI data acquisition boards from IOtech, Cleveland, OH, are multi-function I/O boards with isolated signal conditioning options. The series consists of six boards, with different analog and digital I/O combinations, that can be configured individually or in any combination of up to eight boards per CompactPCI chassis. Input expansions of up to 256 channels can be supported with scan rates up to 5 µs/channel. Up to 470 channels of analog and digital I/O can be accessed from a single board using a single high-density connector and cable. Features common to all boards in the series include 16 16-bit analog inputs, four high-speed counter/pulse inputs, synchronous scanning of all channels, and more than 30 signal conditioning options for measuring temperature, pressure, strain, and position with and without isolation.



For More Information Circle No. 740

Correction

The engine simulation image that appeared on the cover of the April issue was incorrectly credited. The model actually was created in pro-fe, a finite element pre/post-processor distributed by adapco of Melville, NY. pro-fe allows users to construct and manipulate large finite element analysis (FEA) models without using large amounts of computer memory. adapco can be reached at 631-549-2300, or visit www.adapco.com.



Join the Celebration!

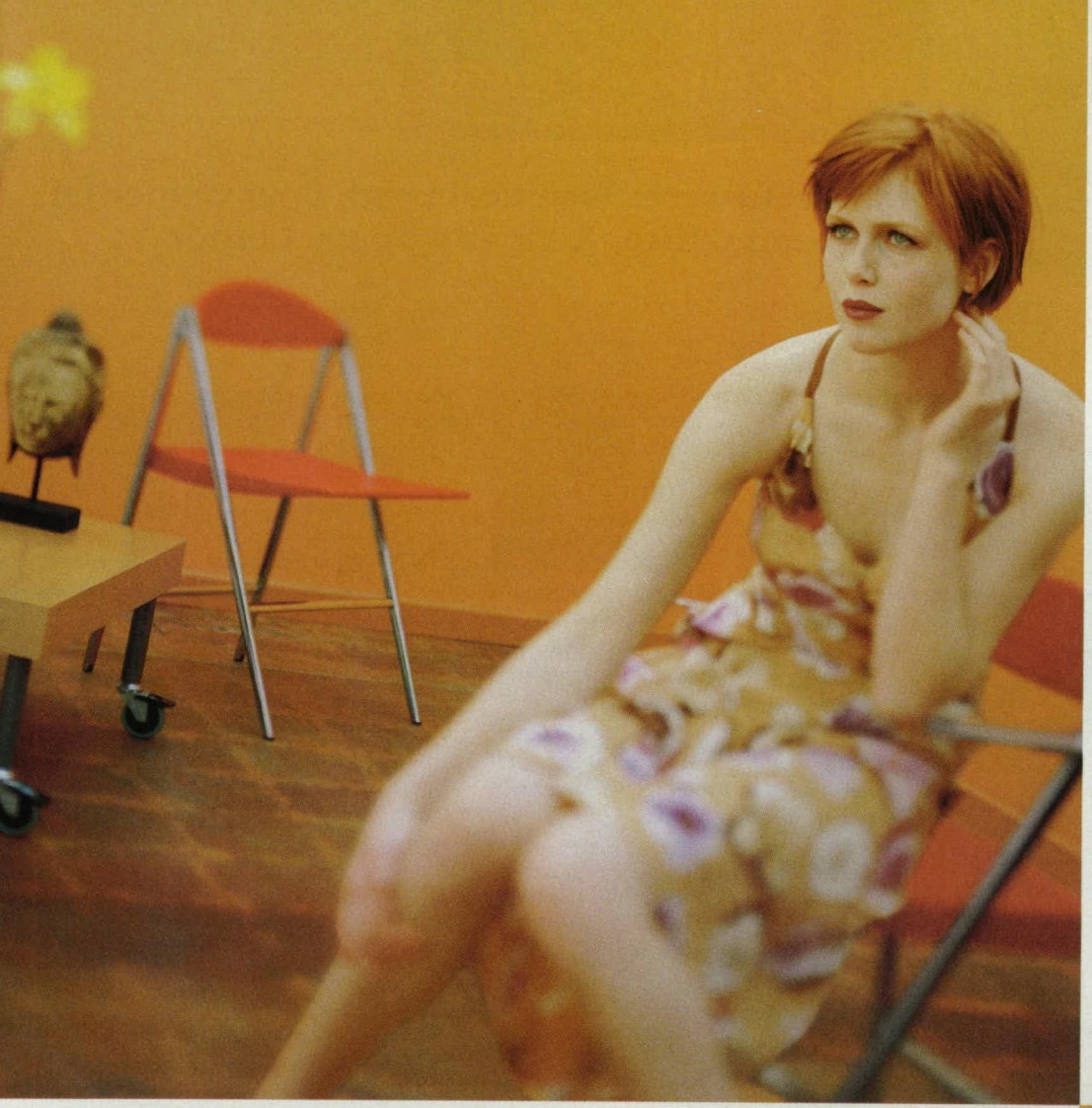
This year marks the 25th anniversary of *NASA Tech Briefs*, and we're planning a very special double issue in December. The commemorative issue will feature a retrospective of 25 years of technology innovations as you've seen them through the pages of *NASA Tech Briefs*. We'll also profile visions of tomorrow — where technology is headed in areas such as software, medical, manufacturing, computers, communications, and electronics.

Most of all, we want you to help us celebrate. We've got a contest especially for you — the readers — who have made our first quarter-century possible. We want to know how *NASA Tech Briefs* has impacted your work and your life. So whether you've been reading the magazine for two years or 25 years, you're eligible to enter.

Tell us how the technologies and products featured in *NASA Tech Briefs* over the years have helped you solve problems and grow your business. Have you established partnerships with NASA or licensed a NASA technology? Which technologies or products are you reading about today in NTB that you think may drive important innovations in the next 25 years?

To enter, go to **www.nasatech.com/25letters**, fill out the brief profile, and tell us, in 200 words or less, what *NASA Tech Briefs* means to you. All entrants will be eligible to win some great prizes, and five winning letters will be printed in our December anniversary issue, which will be distributed to the White House, Congress, and top NASA officials, as well as delivered in .PDF format on-line with hot links from ads and articles.

Let's hear from you!



> Poltrona Frau is world-renowned for furnishings for homes, public spaces, even luxury cars. How does a company steeped in handcrafted tradition speed manufacturing to keep pace with consumer demand today? **thinkdesign.**

Its powerful solid and surface modeling tools help Poltrona Frau designers visualize complex forms and interactions quickly, so they can go from sketches to 3-D models in just hours—leveraging popular designs like the "Donald" chair into broader, more profitable product lines in days, not months.

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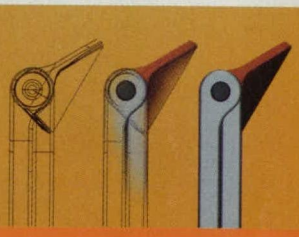
When Poltrona Frau's furniture designers needed to cut project development time from months to days, they sought a 3D CAD application with the same blend of refinement and functionality.



> When folded, you'll recognize that famous profile that gives the "Donald" chair its name.

800.323.6770 | www.think3.com

For More Information Circle No. 561

Mario Busacca, Technical Lead, Environmental Program Office, Kennedy Space Center

Mario Busacca is the Technical Lead for the Planning and Special Projects Group in the Environmental Program Office at NASA's Kennedy Space Center in Florida. His responsibility is to ensure that any environmental-related issues and projects are conducted under the parameters set down by the National Environmental Policy Act.

***NASA Tech Briefs:* What environmental projects are you currently working on at Kennedy Space Center (KSC)?**

Mario Busacca: At KSC, we have approximately 140,000 acres of land and water. And of that land, much of it is wetlands. Whenever we want to build a new facility, or we need some new infrastructure to support the space program, we need to look at where we're going to place that. If we're going to impact wetlands, which sometimes we have to, we have to do some mitigation, which can involve creating new wetlands, or enhancing or restoring existing wetlands that are in poor shape.

In order to make that an easier process, and also to serve the environment, we are trying to develop a long-term wetlands restoration program. At KSC, of those 140,000 acres, we only use about 3,000 to 4,000 of them for space-related activities. The remainder is managed for us under a special agreement by the Fish and Wildlife Service and the Merit Island National Wildlife Refuge. We work hand in hand with them, but they do the land managing.

NTB: Do you have a set timetable for the project?

Busacca: We have a couple of different restorations we're doing. With each type, you have a different type of timetable. One thing we're doing has to do with mosquitoes. We sit between the Indian and Banana Rivers, which is part of the Indian River lagoon. We own about 60 percent of the impoundment in the lagoon, which is about 180 miles long. The way mosquito impoundments work is that you put a dike up around those wetlands and during the mosquito breeding season, they are flooded to stop the mosquitoes from laying their eggs. So that has impacted the functionality and the ecology of those wetlands.

NTB: How do you deal with requests for assistance from the commercial community?

Busacca: We are a federal facility and we do receive calls from the commercial community to use our property. Under changes to the National Space Act recently, there has been some legislation that has encouraged NASA to support the commercialization of our space. However, that has not fully opened the lands at KSC to commerce. Any commercial venture that would want to come onto the Center would have to meet a series of criteria. Most of our land is not directly used for commercial or space-related activities. It acts as a buffer to the outside community. Quite frankly, if we didn't have the Kennedy Space Center where it is, it would probably be condominiums and shopping malls.

We feel that we actually have a really good partnership with the environment and the environmental community, and that our presence continues to help preserve that. Working with the refuge and allowing them to do their job has helped enhance that environment.

NTB: Do you offer your services to communities with local environments that have been damaged?

Busacca: We have offered our expertise; we do have a lot of technology transfers that are happening. We have some remediation procedures that are being tested by ourselves and by the Department of Energy at KSC, and those are going to be available to the general public. That is part of NASA technology outreach. Indeed, that is an integral part of what we do in our remediation program.

A full transcript of this interview appears online at www.nasatech.com/whoswho. Mr. Busacca can be reached at Mario.busacca-1@ksc.nasa.gov.

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For More Information Circle No. 592

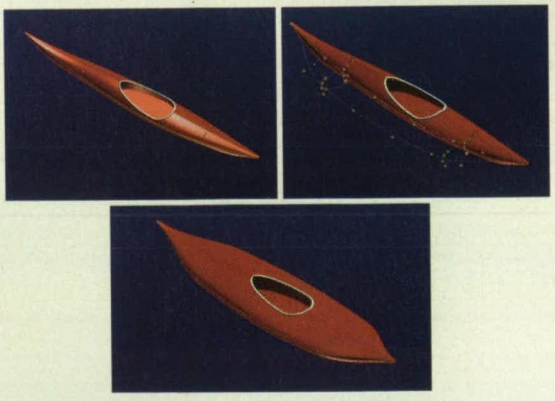
thinkdesign 6.0: A Unique MCAD Offering

Steven S. Ross

This latest version of think3's surface and solid modeler will appeal to designers working on complex — even freeform — shapes or on complex assemblies. In look, feel, and capabilities, it is unlike most other high-end MCAD packages.

To start with, this is one of the few high-end packages that uses its own geometric kernel, rather than a kernel licensed from Unigraphics or Spatial. There's also a new voice-driven interface that has been substantially refined in this version, and has a unique command menu structure. Like Autodesk Inventor, thinkdesign 6.0 is bi-directionally parametric. That is, a part can be based on a parametric association — part A drives part B drives part C, as in normal parametrics — but you can change part C, and parts A and B also will update.

Many designers, however, will simply be drawn to the ease with which the system switches from 2D to 3D, and the ease of drawing and editing complex 3D shapes. It works with highly constrained parametric models of any type (solid models, surfaces, wireframe, or imported geometry). An already constrained and formed object easily can be reshaped in a very intuitive way, even late in the design cycle. I saw a nice demonstration of a bagel cutter's outer shell being modified "on the fly," and another of a sculpted handle being changed in line with the artist's wishes, using a combination of associative surfacing and a new tool called Global Shape Modeling.



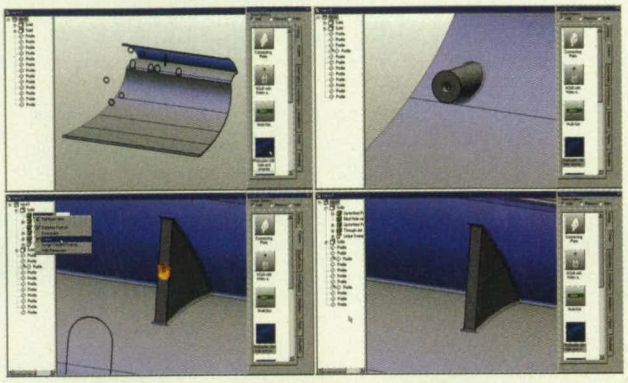
Using the associative surfaces feature of thinkdesign 6.0 to redesign a kayak. The entire structure is modified when the boat is widened.

thinkdesign 6.0 includes a library of hundreds of modifiable "Smart Objects" in application areas such as metal machining, castings, plastic parts, and sheet metal. Users quickly can define new parts as Smart Objects as well. For experienced 3D users, this speeds the design process, of course. But it also allows companies to easily set up libraries of allowable objects, and provides a way to add history when new objects are necessary.

There is an add-on, thinkshape, that expands the shape-based design features. Companies get design histories along with drawings (a feature that has been spreading since Autodesk Inventor was introduced). Another add-on, thinkteam 6.0, provides extra product data management features. It even has a license for a five-user SQL Server setup.

think3 calls the merging of surface and solid modeling "mass 3D." In theory, you can work only in 3D, using a solid modeler. But you can draw a complex solid badly — mating solid primitives wrong, for instance. And solid modelers are not as flexible for doodling because the solid must obey rules about its "real-world" geometry. Surface modelers tend to be faster and more interactive. thinkdesign 6.0, especially with the thinkshape add-on (mold makers in particular will have to have it), lets you move back and forth seamlessly.

thinkdesign has a unique command structure and on-screen conventions. The on-screen views are terrific — a "clearly transparent" improvement over the standard Windows dialog boxes, which hide much of the view they are trying to explain or modify. The mouse commands are another matter — I was just getting used to them after a half-hour of playing. But there's a compatibility mode, with a command line interface that overlays drawing and editing commands similar to AutoCAD. It also comes with a clever adventure game called Time Mechanic that helps you learn how to use it.



Smart objects inside thinkdesign. Here, the standoffs and pins remain where they belong (to mate to other parts) as the shell's geometry is modified.

The whole system is fairly nimble. On fast machines, even fast laptops, shapes appear quickly on-screen. But install plenty of RAM — 128 MB minimum — to get the best results. thinkdesign imports most standard 2D and 3D files. The MCAD engine is thinkdesign ($1,995). More surface modeling features are available with thinkshape ($1,995), and more database features with thinkteam ($995). Photorealistic rendering is possible with thinkreal ($350). The prices are for annual subscriptions, which include support and upgrades.

The company provides on-line training and product seminars, and an on-line searchable knowledge base that includes complete bug reports — a rather refreshing corporate culture. You can buy the software directly from think3 sales or from the company's Web site at www.think3.com. Contact think3 in Santa Clara, CA, at 800-323-6770.

Steve Ross has written several design books, including *Product Safety and Liability:* A Desk Reference (Kolb & Ross, McGraw-Hill, 1979). This fall, he will be a visiting professor at Boston University, co-directing a new Institute for Analytic Journalism.

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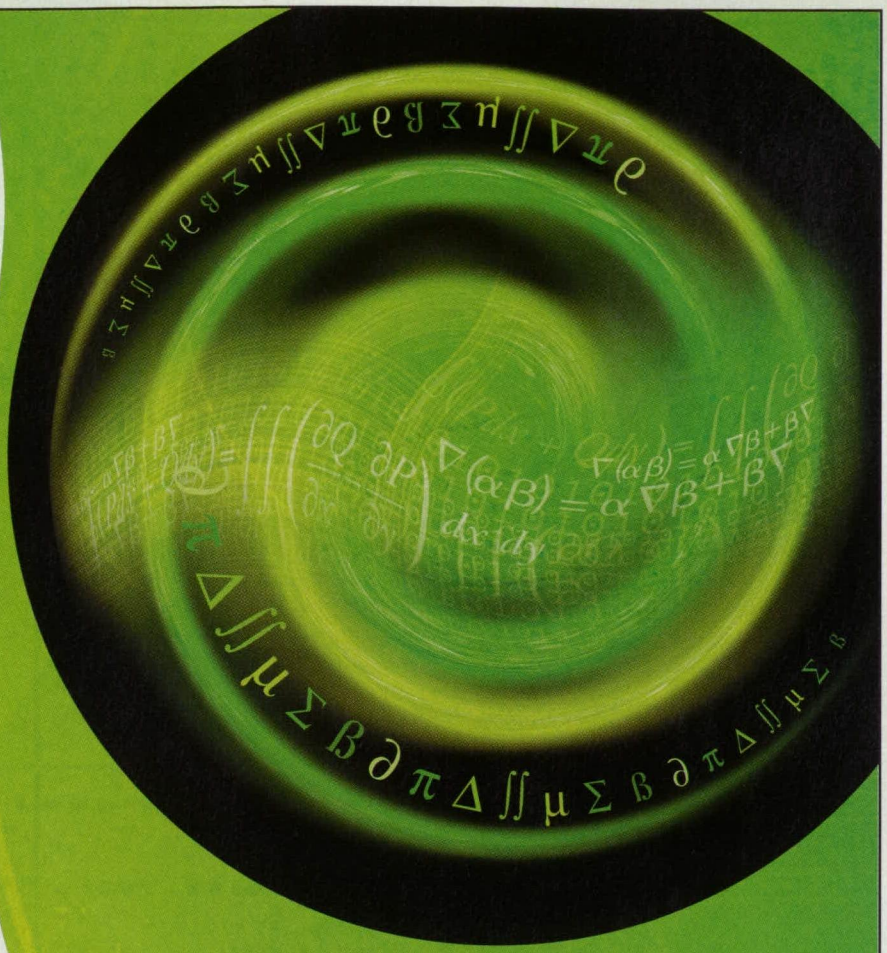

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Technologies of the Month

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New Methods for Tracking and Operating Vehicles Using GPS

Caterpillar

Global Positioning System (GPS) technology helps people figure out where they are by using radio signals from a network of satellites to calculate latitude, longitude, and elevation. Caterpillar has developed a technique that calculates the position of an orbiting satellite without relying upon the satellite's ephemeris data — the information it broadcasts to identify its location. Instead, the satellite's orbit is determined by measuring the distance to the satellite at different times. This provides much more accurate positioning data and a more accurate fix on a terrestrial location, enabling the use of a single satellite instead of the usual three to determine a position.

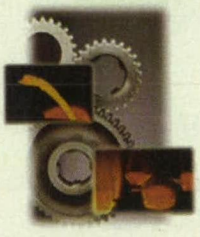
Caterpillar's new technologies have a number of possible applications in vehicle positioning, mining, construction, waste disposal, landscaping, and other uses where vehicles are deployed, either autonomously or with onboard operators.

Get the complete report on this technology at:
www.nasatech.com/techsearch/tow/caterpillar.html

New Cooling Process Yields Superior Hardened Steel

Joe Powell, President, IQT

Often, a process called heat-treating is used to harden steel, making it stronger for use in vehicles, machinery, and other applications requiring a more rugged alloy. When steel is heat-treated, the iron-carbon matrix molecular structure undergoes transformation through controlled application and removal of heat. A critical step in heat-treating is cooling, or "quenching," because the speed with which the metal is cooled substantially alters its characteristics. A new quenching process called IntensiQuench controls and interrupts cooling to aid uniform martensite formation and beneficial compressive surface stresses.



Benefits include use with any heating source and common steel types; use of lesser alloys through super-strengthening; the production of smaller, lighter steel parts; and reduced distortion and cracking.

Get the complete report on this technology at:
www.nasatech.com/techsearch/tow/iqt.html

New Process for Producing Optical Quality, Low Cost Plastic Films

Steven D. Fields, Rohm and Haas Company

The use of liquid crystal displays (LCDs) has become so widespread because low-cost, high-quality LCDs are readily available. Rohm and Haas has developed an alternative manufacturing process that delivers both high-quality and low-cost plastic films suitable for use as plastic substrates and in other optical applications. The key to this technology is a stress-free optical (SFO) manufacturing process that utilizes a new process paradigm for producing optical quality plastic films. This novel, continuous process can form a variety of thermoplastic resins such as acrylics and polycarbonates into optical-quality films.

The process requires no solvents and provides films with ultra-smooth surfaces and low internal stresses, resulting in ultra-low optical retardation and low thermal shrinkage. In addition, films made using the SFO process may find applications in other areas, including optical data storage media.

Get the complete report on this technology at:
www.nasatech.com/techsearch/tow/rohmhaas.html

Environmentally-Safe Flame Retardant for Polymers

Hideki Nakagawa, Asahi Glass Co.

With the increasing use of plastics in everything from appliances to furniture, when a fire breaks out, the risk of injury or death is as great — if not greater — from toxic smoke as it is from the actual flames. Many manufacturers are using flame-retardant compounds for producing plastic components; however, many of these flame retardants, such as those containing halogen, are toxic and environmentally hazardous. This new inorganic flame retardant can be used in many of the most popular polymers and thermoplastic resins, such as polyethylene, polypropylene, polyester, polyvinyl chloride, polystyrene, nylon, and polycarbonate. The compound is comprised primarily of a low-melting glass containing a large amount of a phosphorous substance. When used with chlorine-containing polymers such as polyvinyl chloride (PVC) , it acts as a smoke suppressant.

This versatile compound can be molded easily, making it ideal for applications such as plastic housings for electronic devices, seat cushions, automotive parts, and plenum and riser communication cable sheathing.

Get the complete report on this technology at:
www.nasatech.com/techsearch/tow/agc.html

July 2001

PHOTONICS Tech Briefs

PHOTONICS SOLUTIONS FOR THE DESIGN ENGINEER

InGaAs Arrays: Near-IR Detector of Choice

New Products — see page 22a

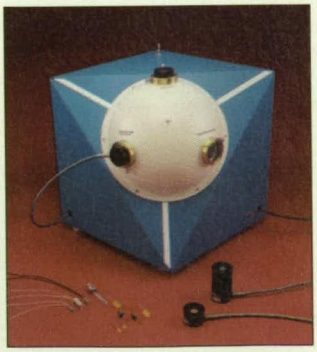
PHOTONICS Tech Briefs

Supplement to *NASA Tech Briefs'* July 2001 Issue Published by Associated Business Publications Intl.

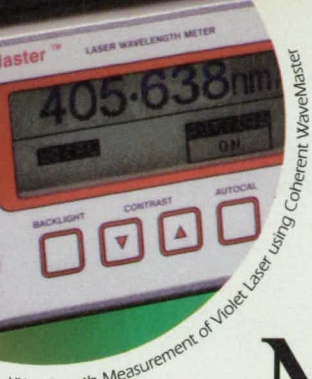
Features

Tech Briefs

Departments



On the cover: *International Light's INS250 integrating sphere. Photo courtesy International Light Inc., Newburyport, MA.*



Wavelength Measurement of Violet Laser using Coherent WaveMaster

No "Shrinking Violet"

4 mW Violet Laser System

New Longer Lifetime Violet Lasers

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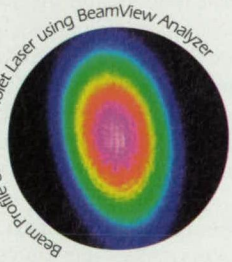
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Near-Infrared Arrays Turn to InGaAs

Some practical considerations about the use of an increasingly popular detector.

Optical spectroscopy has rapidly evolved to meet the increasingly demanding needs of its users as one of the preeminent measurement tools in scientific research. In its most basic form, the individual components of an optical spectroscopy system include a light source, a light-dispersive medium, and a detector. Advances in all three components have led to tremendous gains in the ability to obtain data. Arc lamps and lasers have replaced simple blackbody elements as light sources. As fabrication methods of gratings and mirrors have improved, dispersive elements, specifically spectrometers, have become more efficient.

As the semiconductor and telecommunications industries continue to grow more sophisticated, the near-infrared (NIR) region of the spectrum is coming in for increasing interest for the characterization of optical fibers, filters, light sources, semiconductors and other related materials. Over the past decade the most dramatic improvements in spectroscopic tools have been the advances of detector technology.

Optical spectroscopy detectors convert measured radiant power into an electrical signal that can be processed, recorded, and displayed. There are two main categories of measurement systems, based on either single-channel or multichannel detectors. Single-channel detector systems contain a single element that accepts light through the exit slit of the monochromator. In this system, a spectral measurement is made by rotating the grating of the monochromator and recording one data point for each grating position. The entire spectral bandpass through that slit contributes to the generated signal. This bandpass defines the achievable spectral resolution of the system.

By contrast, a multichannel or array detector system allows a user to simultaneously collect many data points without scanning the monochromator grating. This provides for much more efficient data collection than single-channel counterparts do, because large amounts of spectral data can be collected in a single exposure. First developed mainly for the visible region of the spectrum, multichannel detectors enable collection of hundreds, and in some cases thousands, of data points in a single exposure. No exit slit is used on the spectrometer. Instead, the dispersed spectrum is incident on the detector, which consists of several small and evenly spaced individual detection elements. The most popular multichannel detectors are charge-coupled devices (CCDs). CCDs are typically two-dimensional arrays made of silicon with several hundred elements, or pixels, arranged in a rectangle. For spectroscopy, the longer side of the rectangular array is arranged to coincide with the dispersed spectrum.

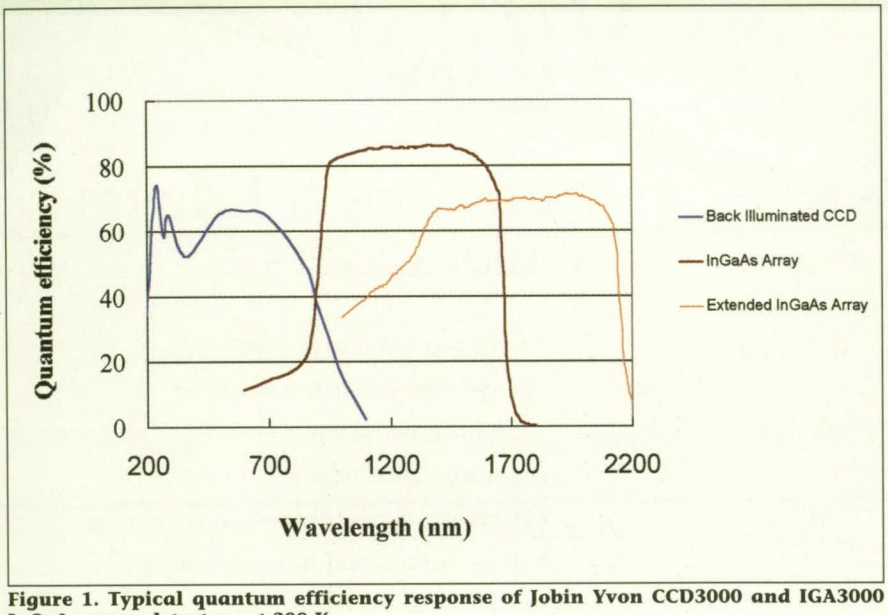

Figure 1. Typical quantum efficiency response of Jobin Yvon CCD3000 and IGA3000 InGaAs array detectors at 300 K.

Scientific-grade CCDs exhibit high responsivity from the near-ultraviolet to the near-infrared region of the spectrum: 200 nm to 1.1 micrometers. At longer wavelengths, the photon energy is lower than the silicon bandgap, and the silicon thus becomes transparent to the incident photons. Three-five materials, however, like indium gallium arsenide (InGaAs), have a lower bandgap and can absorb the NIR photons. For this reason, InGaAs arrays are quickly becoming the array detector of choice between 0.9 to 1.7 micrometers because of their excellent quantum efficiency in this spectral range. By changing the alloy composition of the detector material, the wavelength can be extended up to 2.2 micrometers, although this extension comes at the expense of significantly higher noise levels. Figure 1 displays the quantum efficiency for regular and extended InGaAs arrays, compared to that of a back-illuminated scientific-grade CCD sensor.

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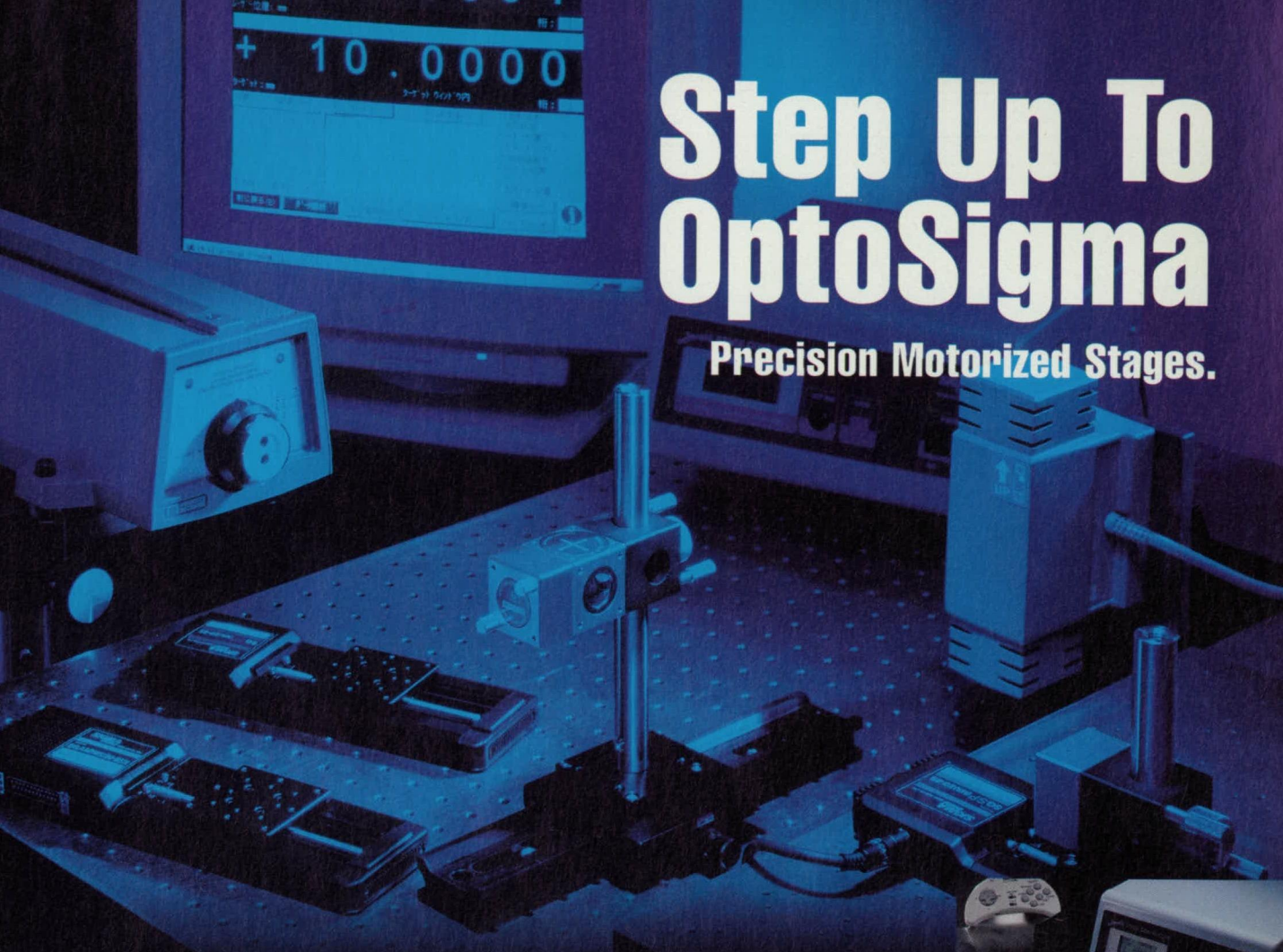

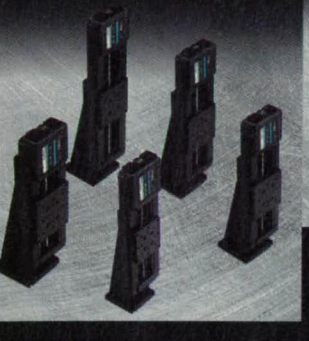

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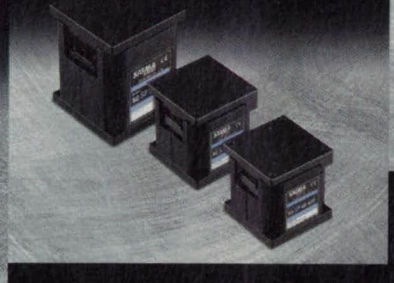

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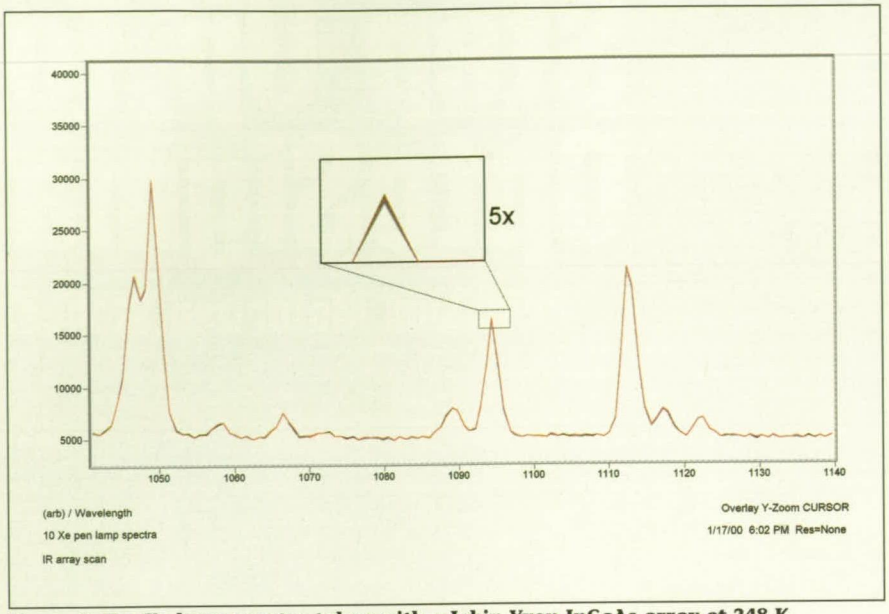

Figure 2. Ten Xe lamp spectra taken with a Jobin Yvon InGaAs array at 248 K.

Understanding Signal-to-Noise

The InGaAs arrays used in spectroscopy are constructed from individual photodiodes arranged in a linear array with a silicon CMOS readout multiplexer circuit. These arrays typically consist of 128, 256, or even as many as 512 pixels, in which active pixel areas of 50 × 500 micrometers provide very high sensitivity. In high-precision low-light-level spectroscopic applications it is important to understand the various noise sources which contribute to a measurement with an InGaAs array and thus affect the signal-to-noise ratio.

Each individual InGaAs photodiode pixel in an array is connected to its own capacitive transimpedance preamplifier circuit. As a result, the bias voltages are often slightly different from pixel to pixel. These minute differences lead to a predictable and repeatable noise source known as fixed pattern noise. This noise source is a strong function of both the integration time and the array operating temperature, and can be reduced by cooling the array with either thermoelectric or liquid nitrogen cooling. Fortunately, the fixed pattern noise is highly repeatable and can be almost completely eliminated by subtracting a dark acquisition of the same integration time as the illuminated spectrum of interest.

In order to accomplish the dark acquisition, it is mandatory to optical-block the signal to the detector, using a mechanical shutter. Some InGaAs arrays have an electronic sink circuit that dumps the photocurrent and essentially flushes the detector in a manner analogous to a CCD detector. This so-called "electronic shutter" does not permit a dark acquisition to be made, but it does allow the user to set a fast integration time. Other sources of noise in an InGaAs array that contribute to the measurement include read noise, which is electronic noise that occurs when the elements are read out, and dark signal, which is the unilluminated response of the detector.

figures of merit are defined and influence the measurement, are of critical importance in comparing InGaAs array detector performances. For example, is the readout noise equal to the total readout noise, including contributions from the photodiode, amplifier, and CMOS multiplexer components, or is it simply but incorrectly the multiplexer noise.

Thus, the total noise signal is:

$$\text{noise}_{\text{total}} = \sqrt{\text{noise}^2_{\text{fixed pattern}} + \text{noise}^2_{\text{read}} + \text{noise}^2_{\text{dark signal}} + \text{noise}^2_{\text{shot}}}$$

Reducing the detector temperature can reduce the total noise signal of a detector. When an InGaAs array is cooled, however, the long-wavelength response cutoff changes at a rate of 1 nm/K. From a practical point of view, the measurements with an InGaAs array are often shot-noise limited. In this case the reproducibility of the complete system is of importance in ensuring repeatable measurements. Figure 2 represents ten individual spectra of a Xe pen lamp source using a spectrometer with a 320-nm focal length and two-stage thermoelectrically cooled (-25 degrees C) regular InGaAs array. As demonstrated by this figure, the spectra overlay one another nearly perfectly, indicating the very high reproducibility of the detection system.

Figure 3. A NIR spectroscopic system with a liquid-nitrogen-cooled Jobin Yvon IGA-3000 InGaAs array detector mounted on a Triax 320 imaging spectrograph.

The total noise in the measurement contains contributions from all sources of dark, readout, fixed-pattern, and shot noise. Shot noise, the intrinsic noise distribution in the photon signal, is equal to the square root of the total signal. A clear understanding of the noise process and the technical specifications of the detector, and how these

The primary advantage of using an array detector such as the Jobin Yvon IGA3000 InGaAs array is the fast data acquisition rate. For example, a measurement containing 500 data points obtained with a one-second integration

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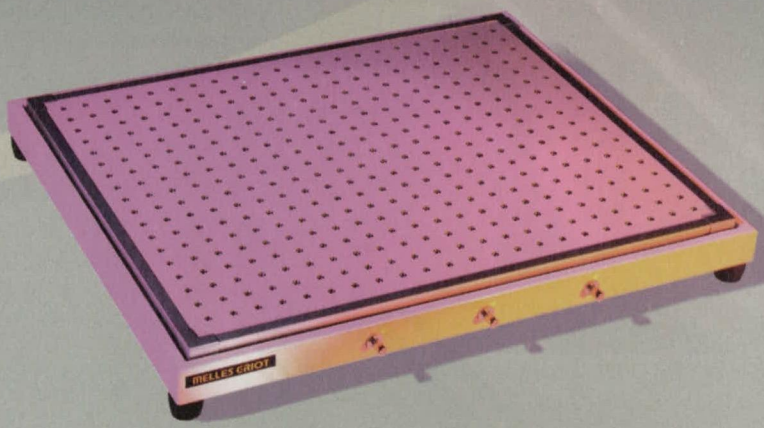

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time will take one second to acquire, whereas with a scanning detection system it will take more than 500 seconds. Thus there is little penalty in using the speed advantage of the array to take multiple spectra in order to improve the signal-to-noise ratio under low-light-level conditions. The signal-to-noise ratio of the resultant averaged spectrum is improved by a factor of $\sqrt{n}$ (called the multiplex or Fellgett advantage). For example, if 100 spectra are acquired and averaged, the signal-to-noise ratio of the resultant spectrum will improve by a factor of ten.

Spectroscopic Systems and Software

For optimum use in spectroscopic applications, InGaAs array detectors must be mounted onto an imaging spectrograph. Such spectrographs, like the Jobin Yvon Triax 320 (Figure 3), have correcting optics that disperse the spectral information across a flat field in the exit plane of the instrument. This allows the array detector, mounted at the exit plane, to collect large amounts of spectral information in a single exposure. Note that, in general, InGaAs arrays are between 250 and 500 micrometers in height. Accurate imaging onto the detector is critical to ensure maximum optical coupling from sample to detector, hence maximization of the signal-to-noise ratio, and to ensure uniform illumination across the array.

It is also very important for spectroscopic applications that the detector and the spectrograph be controlled by a single dedicated spectroscopic software package. In these applications, the data from the InGaAs array needs to be specified as a function of wavelength. By itself, however, the array cannot differentiate between the wavelengths of light incident upon it. The imaging spectrograph is responsible for that function. Because different spectrometer and grating combinations have different spectral dispersions, the spectrum over the IR array changes with the varying conditions. If the dispersion and central wavelength are known, the software can calculate wavelength-dependent data from the NIR array.

Proper spectroscopic software should be able not only to read the data and convert it into a useful format (e.g., wavelength versus counts), but also to change the state of the devices to make the appropriate measurements. For a movable-grating spectrometer, the software must be able to change the center wavelength to allow measurement of the area of interest. For the InGaAs array, gain selection via the software is essential. The most complete spectroscopic packages not only read the data in the desired format, but also have extensive provision for data analysis and display. In the applications examples that follow, integrated systems consisting of an InGaAs linear array, spectrometer, and complete spectroscopic software provide data to satisfy the varied areas of spectroscopy.

Photoluminescence Spectroscopy

Photoluminescence (PL) spectroscopy is a simple and powerful technique that is widely used in the semiconductor industry for material characterization. In PL measurements, a sample is irradiated with a visible light source, which stimulates the solid-state material to an excited electronic state. As this excited state relaxes to the ground state, it emits light at a wavelength dependent on the material properties. Thus the PL technique can provide information about the material bandgap, impurity content, alloy mix, homogeneity, and thickness of the epitaxial layers.

In conventional PL systems, a scanning monochromator equipped with a single-element InGaAs detector is used for ana-

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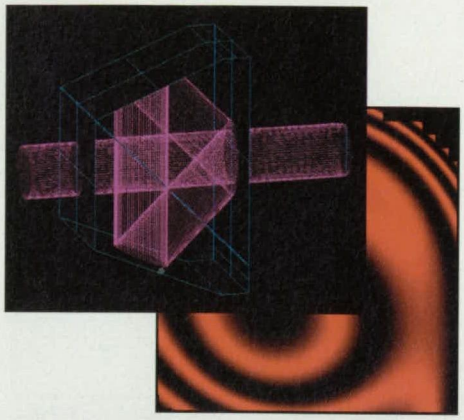

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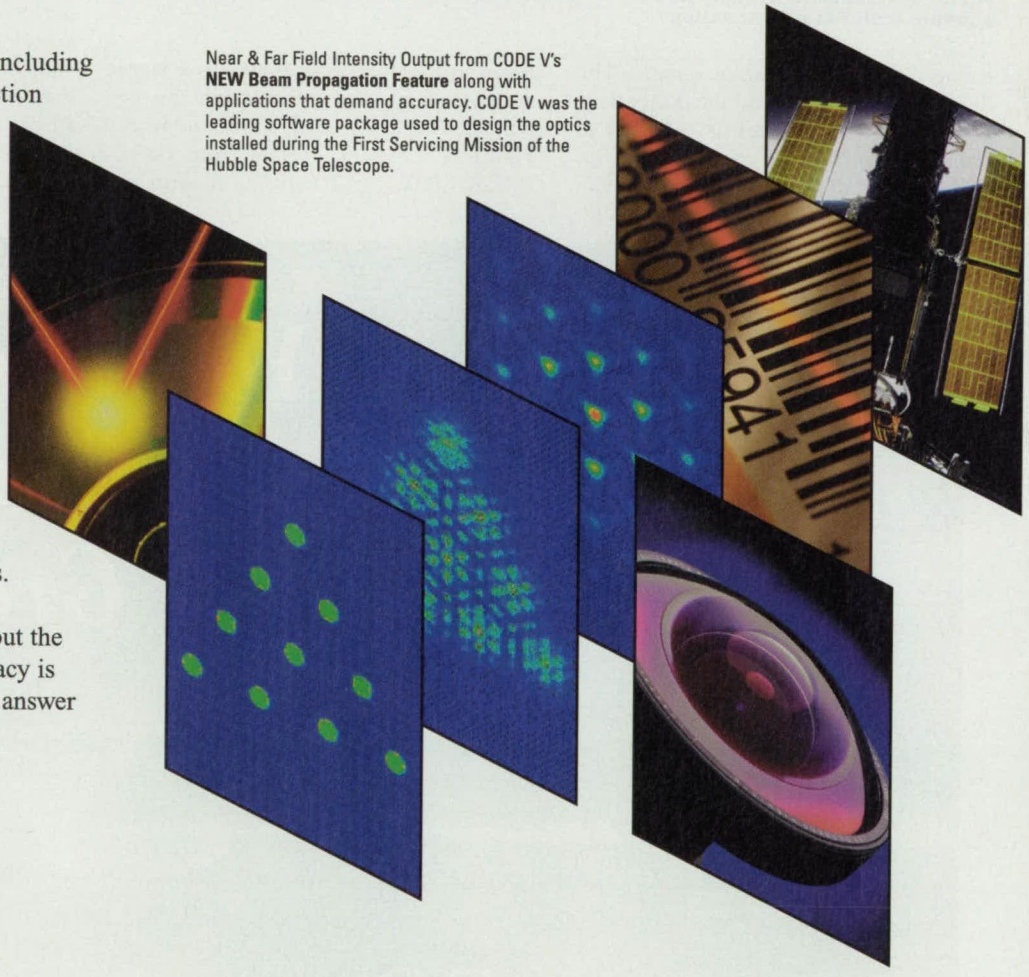

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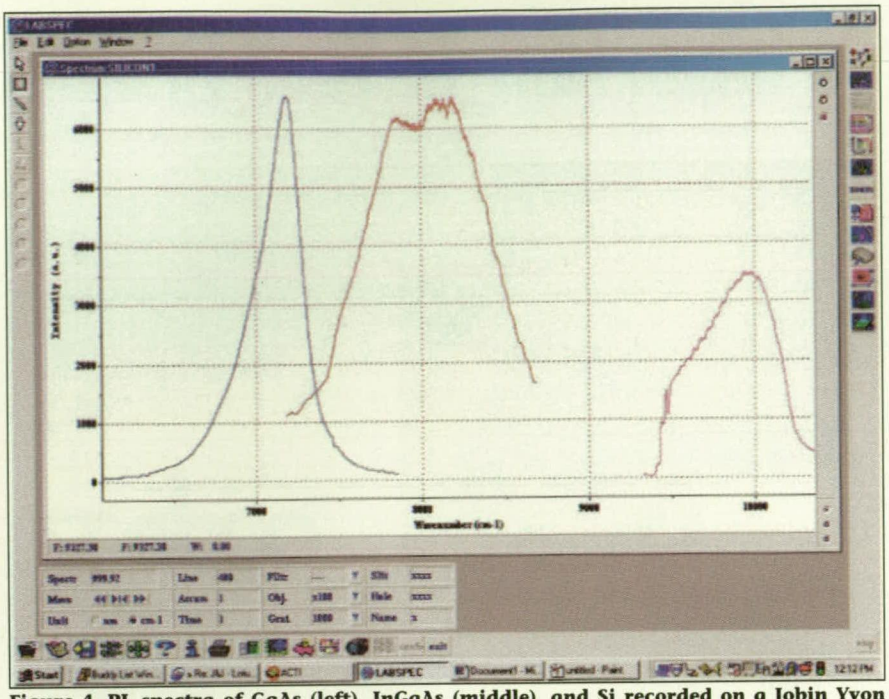

Figure 4. PL spectra of GaAs (left), InGaAs (middle), and Si recorded on a Jobin Yvon LabRam with 532-nm excitation.

lyzing the emission from a sample. The drawback with this technique is that a significant amount of time is required to collect a single spectrum. With an InGaAs array detector mounted onto an imaging spectrograph, however, a large amount of spectral information can be collected quickly and simultaneously. Figure 4 shows PL spectra from GaAs, InGaAs (unknown composition), and silicon obtained with a 256-element liquid-nitrogen-cooled Jobin Yvon InGaAs array detector mounted on a Jobin Yvon LabRam imaging spectrograph. The spectra were collected from room-temperature samples excited by a 532-nm laser with a one-second integration time. Note the excellent signal-to-noise ratio obtained with these measurements even for a one-second measurement time.

Other applications of NIR optical spectroscopy using an InGaAs array detector include Raman spectroscopy, singlet oxygen fluorescence monitoring, IR laser diode characterization, and photoreflectance. The number of applications is growing rapidly, as InGaAs IR arrays make previously difficult applications more feasible. As part of an integrated system including spectrometer and software, InGaAs arrays will become an increasingly important instrument for the infrared spectroscopist.

For further information , please contact the authors of this article, Dr. John R. Gilchrist, director of the optical spectroscopy division, and Dr. Linda M. Casson, an applications engineer in the same division at Jobin Yvon Horiba Inc., 3880 Park Avenue, Edison, NJ 08820-3012; (732) 494-8660 (Gilchrist ext. 131, Casson ext. 153); www.jyhoriba.com.

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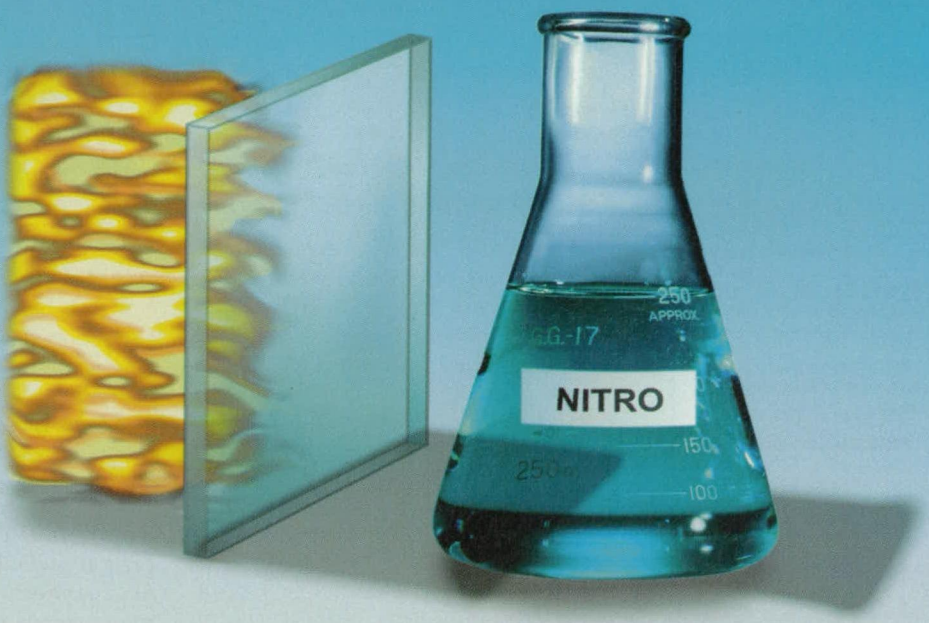

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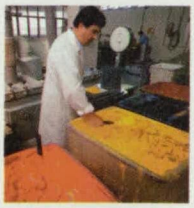

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Recent photonics briefs published in NASA Tech Briefs

Many photonics-related briefs from NASA's field center laboratories appear in *NASA Tech Briefs* rather than in the *Photonics Tech Briefs* supplement. Listed here are some from issues of *NASA Tech Briefs* just past, edited for brevity and indexed with reference to original publication and the availability of a Technical Support Package on *Photonics Tech Briefs'* web site.

NASA Tech Briefs April 2001, page 44

Micromachined Broad Band Light Sources (NPO-20655)

A team at NASA's Jet Propulsion Laboratory and Glenn Research Center has designed and fabricated a novel micromachined incandescent light source that operates at temperatures exceeding 2,500 K. The high-temperature tungsten-filament-based source has a high-brightness emission over a broad spectral band. The monolithic design allows for ease of incorporation with on-chip electronics as well as with fiber optics. This device can be used for miniature spectroscopic instruments and for automotive dashboard displays.

For further information, access the Technical Support Package (TSP) ***free on-line at www.ptbmagazine.com*** *under the Electronic Components and Systems category.*

NASA Tech Briefs May 2001, page 70

Simple Fiber-Optic Coupling for Microsphere Resonators (NPO-20619)

A team at NASA's Jet Propulsion Laboratory has devised simple fiber-optic couplers for use in coupling light into and out of the "whispering-gallery" electromagnetic modes of transparent microspheres. The need for this type of coupling arises in conjunction with the use of these microspheres as compact, high-Q (where Q is the resonance quality factor) resonators, delay lines for optoelectronic oscillators (including microlasers), and narrow-bandpass filters. The coupler is fabricated by cleaving and polishing the tip of a single-mode optical fiber at an angle to form a microscopic coupling prism integral with the fiber. If a microsphere is placed near the angled surface and within the evanescent field of the fiber-optic core, there is an efficient exchange of energy in resonance between the waveguide mode of the fiber and a whispering-gallery mode of the sphere.

For further information, access the Technical Support Package (TSP) ***free on-line at www.ptbmagazine.com*** *under the Physical Sciences category.*

NASA Tech Briefs May 2001, page 71

Surface Gratings for Optical Coupling with Microspheres (NPO-20618)

Researchers at NASA's Jet Propulsion Laboratory have shown that a diffraction grating consisting of a periodic gradient in the index of refraction of a thin surface layer can be effective as a means of far-field coupling of monochromatic light into or out of the "whispering-gallery" electromagnetic modes of a transparent microsphere. Far-field coupling is preferable to near-field coupling in applications in which there are requirements for undisturbed access to the entire surfaces of microspheres, including a gate based on coupling between a high-Q (where Q is the resonance quality factor) microsphere and trapped individual resonant ions.

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NASA Tech Briefs June 2001, page 36

Rare-Earth Optical Temperature Sensors (LEW-17138)

A team at John H. Glenn Research Center has developed a type of fiber-optic temperature sensor that utilizes narrow-band near-infrared radiation emitted by rare-earth ions. These sensors can have a maximum operating temperature that can equal or exceed 2,000 degrees C, the exact values depending on the choice of fiber-optic and rare-earth-containing radiative materials. The sensor is an optical fiber, coated at its input (hot) end with a film containing a rare earth. The tip of the fiber is put in contact with the object, the temperature of which is to be determined. Radiation at the input end of the fiber travels to the output end, then through a filter with a narrow pass band, and impinges on a photodetector, the output of which is processed to obtain the temperature.

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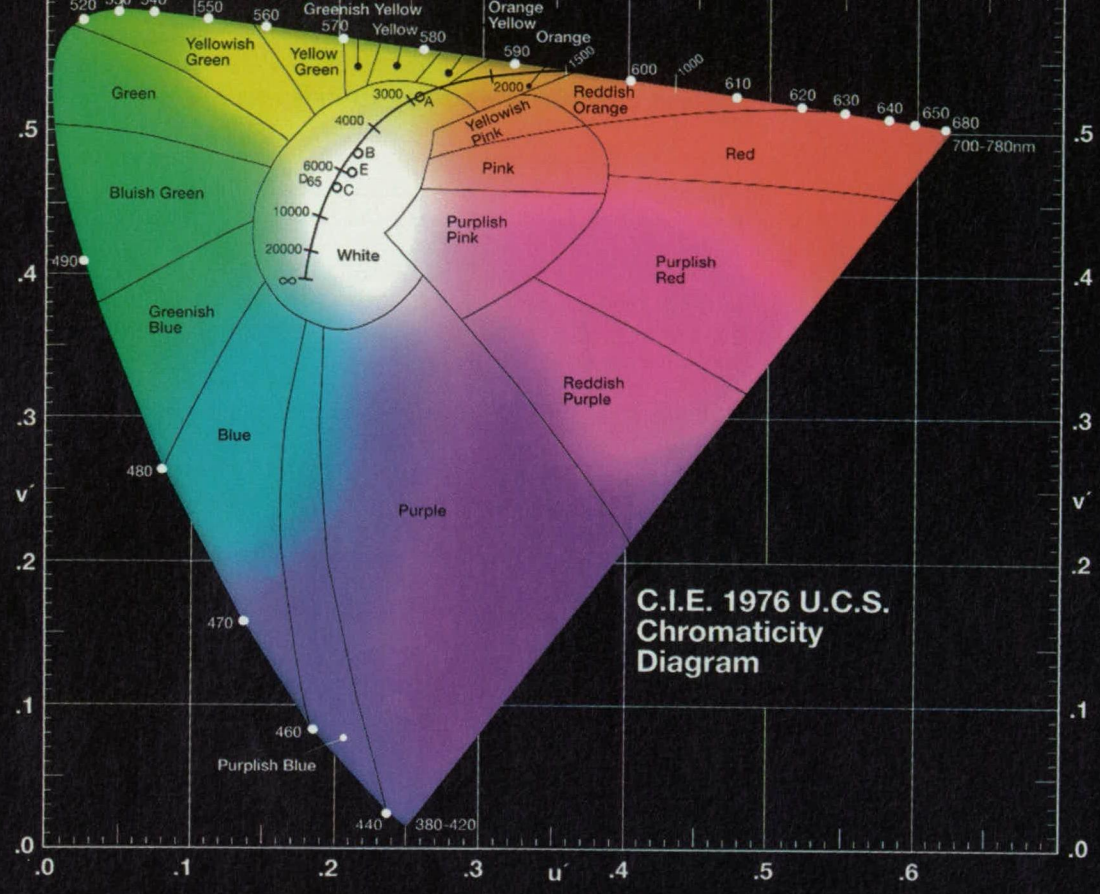

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NASA's Jet Propulsion Laboratory, Pasadena, California

Common-path heterodyne interferometers (COPHIs) have been proposed for measuring small variations in the heights of surfaces. A COPHI could be used, for example, to measure the deviation of the surface of a mirror or other optical component from nominal flatness or nominal sphericity. Like phase-shifting interferometers that have been used previously for the same purpose, a COPHI would generate an optical-phase map equivalent to a topographical map of the surface under test. The advantages of the COPHI over a phase-shifting interferometer would be (1) greater resolution in phase and thus in surface height and (2) shorter measurement time.

The figure depicts a COPHI for measuring the deviation of a mirror from flatness. The light from a laser would be split into two coherent beams, denoted 1 and 2. By use of an acousto-optical modulator, beam 1 would be modulated at a radio frequency f_1. In the same manner, beam 2 would be modulated at frequency f_2, which would differ from f_1 by a convenient amount, e.g., 10 kHz. Half of beam 1 would pass through beam splitter 1. The mirror under test would be positioned to retro-reflect beam 1. After reflecting off beam splitter 1, beam 1 would combine with beam 2 at beam splitter 2 to an form interference fringe.

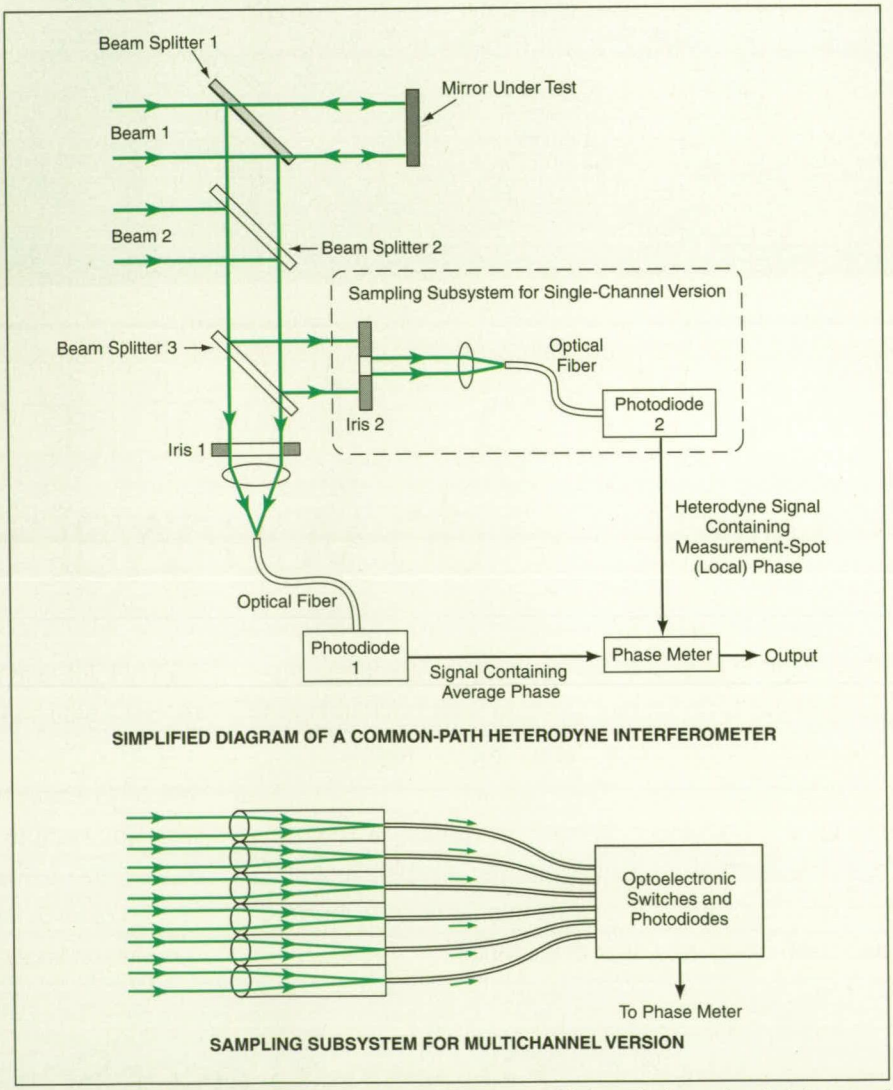
The interference fringe would then be split into two identical sets with beam splitter 3. One set of fringe would pass through a large iris 1, which would sample the entire portion of the mirror surface. The light would be coupled into and through an optical fiber to photodiode 1; consequently, the phase of the $|f_1 - f_2|$ frequency heterodyne output of photodiode 1 would amount to an average over the entire mirror surface. This heterodyne output would be used as a reference signal (REF). The other set of fringe would then pass through a much smaller iris 2, which would select a small spot on the mirror for measurement. After passing through iris 2, the light would be coupled into and through a second fiber to photodiode 2. This heterodyne output would be used as measurement signal (UNK). The phase of the $|f_1 - f_2|$ frequency heterodyne output of photodiode 2 would thus correspond to the surface height at the measurement spot.

A high-resolution phase meter would measure the phase difference between UNK and REF, thus providing a measurement of the deviation of the measurement-spot surface height from the average surface height of the mirror. Because of the common path nature of REF and UNK signals, many error sources such as vibration would become common-mode error in the measurement. This interferometer configuration would allow much higher resolution than phase-shifting interferometers.

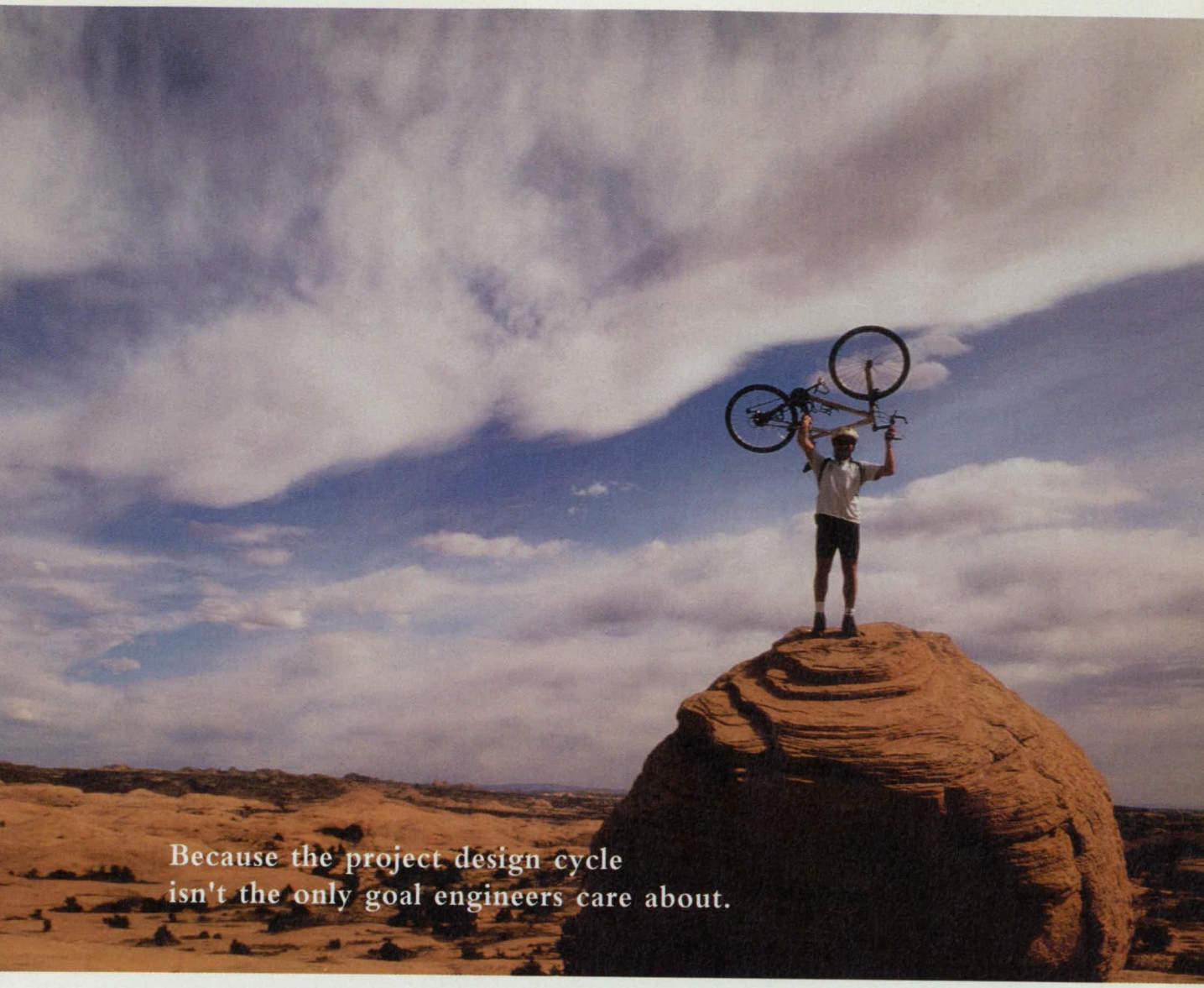
A surface-height map of the test surface could be generated from phase readings acquired in a mechanical scan of iris 2. Of course, such a scan would take some time. To eliminate the need for mechanical scanning, one could construct a multichannel version of the COPHI: Iris 2 would be replaced by a 2-D array of lenslets registered with input ends of many optical fibers. Each optical fiber would define a pixel in the interference image of the test surface. The output ends of the optical fibers would be connected via an optoelectronic switch to a smaller number of photodiodes. By a combination of electronic and optoelectronic switching, the outputs of the photodiodes would be fed sequentially to the phase meter to generate a sequence of phase readings, each corresponding to one pixel.

This work was done by Feng Zhao of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Systems category.*

NPO-20786



A **Common-Path Heterodyne Interferometer** could generate a high-resolution surface-height map of a mirror surface under test. A multichannel version would be capable of sampling the surface under test in a relatively short time.



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Fractal-Based Encryption

Encryption methods based upon nonprobabilistic nondeterminism show promise in the optical age.

Catnaz Incorporated, Columbus, Ohio

In 1987 a discovery led to the formal proof that it is possible to use chaotic functions to arrive at a nonprobabilistic and nondeterministic method to encrypt information. Over the years, as experimentation budgets have allowed, the principal researchers have been able to verify the original work and methodology. In 2000 the first live messages were sent over the Internet using TCP/IP over an NT network. This has subsequently been followed on by using IPX/SPX over a Novell network.

The methodology itself is very straightforward. A chaotic function is used to encrypt a bit stream into a totally nonreadable output. This bit stream also has the added benefit that if the message is tampered with or intercepted, the bit stream is corrupted and is not able to be decrypted.

In the normal context of the operation of this system, and by using a virtual operational environment, the investigators are manipulating data in eight dimensions, which require a sixty-four discrete coordinate system, using eight nominative octets. Each octet is further addressed using the characters 0 through 9, and lower- or upper-case letters from A to Z. These provide the ability to address using normal ASCII characters. This format was chosen to ensure backward and forward compatibility with external third-party-written software.

This original discovery has led to the fundamental principle that the main focus of any chaotic system was what the output would look like. After watching hundreds of runs of Edward Lorenz's strange attractors show up in places that were seemingly endless, it was decided that the team would pursue the goal of placing this type of behavior into a software/hardware combination that would supply the necessary functionality and still be robust enough for a PC or minicomputer format. This was accomplished when the first modules of Fortran were created; then, as time went on in the development process, the investigators translated some of the harder features into what languages were available and able to be used.

The system that was decided upon was one where a combination of hardware and software was used. The hardware provided a means of proper transmission and error correction, and the software was utilized to create the front end and all of the virtual mechanisms used to create each message block, or octet as the case may be.

It was also discovered that this same functionality would allow the messages to be combined into still larger messages in a differential cryptographic type of format. When this was demonstrated, a single message contained several megabytes worth of data. The message blocks themselves did not contain more than a minimum of 56K to a maximum of 128K in total length.

This mechanism of storage was based on the chaotic functions of the original work.

There were additional discoveries to be made with this format, and many of these were going to be even more interesting scientifically. It was discovered that the messages could be used for storage after the shell had been created for the final encrypted product. The baseline addressing schemes started at 1024 bits, went to 2048, and then finally stopped at 2048 × 2048, or 4,194,304 bits in the single message matrix. This single matrix was demonstrated to be able to hold several orders of magnitude above the original test shell. In testing, the actual message block has contained a five-to-one ratio of encrypted data to original matrix. The largest block to date is more than five hundred megabytes with a nominal shell of three megabytes.

The message matrix, at the present time, is translated into the standard two-dimensional hardware addressing that the hardware will support. There is additional experimentation with optical methods to ensure that the output of the product is translatable into three and higher mathematical dimensions. While the creative mechanism is based upon a VRML format, the main message unit is easily translatable into any known or projected translational mechanism.

This was arrived at by multiple-level addressing: taking the single address, and then combining them with lower and lower addresses. An example of this would be a situation where the zip code of a city describes a geographic region. The street address is another layer, and finally the house number, describing a physical location.

This addressing schema is error-corrected, and supports existing software and hardware devices to ensure the platform is nonproprietary after the message is encrypted. The encryption mechanism is such that the messages are layered one on top of the other with the error-correcting codes built in. This is to ensure accuracy in the message encryption process, and will enable the message to be recreated accurately in case of damage in transmission, or other electronic disruption.

The next focus of the effort will be a fixed two-dimensional format in the form of a smart card with the addressing scheme engraved into the substrate. The team chose a polyester sub-base with optically opaque infrared-transparent material. This was chosen to ensure tamper resistance for any smart cards or identification cards using this technology.

The greatest difficulty has been scratch resistance for the cards, and message length over suitable networks. The largest experiment to date has been in the transaction protection mechanisms of the test network, where the first live data transmission tests occurred. The tests also showed that the message length was of less importance than the transmission speed at which it was sent.

Another focus has been in the creation of fixed, nonmovable memory arrays on the polyester cards that were part of the original development process. The main limitation on this technology has been the difficulty in obtaining test materials and equipment, due to the size limitations of the test equipment. It is expected that the next phase of testing will be in packetization, and routing mechanisms for transmission of larger volumes of information within the framework of the original message matrix.

In experimentation it was demonstrated that the chaotic functions were

robust enough to be used to their theoretical limitations in usage with DES, or Triple-DES functions. This was chosen to allow usage of a Kerboros or other to-be-developed public key infrastructure. The methodology allows this system to be used with independently developed software and hardware. It was originally developed for the protection of a financial transaction network for a client that subsequently went bankrupt.

This work was done by principal investigators in the Aerospace Division of **Catnaz Inc.** *of Columbus, Ohio. For further information on this technology, contact Dr. Gregory A. Hensley at (614) 442-8740; fax (614) 442-8746; www.catnaz.com.*

Capture and Escape of Charge Carriers in Quantum Dots

NASA's Jet Propulsion Laboratory, Pasadena, California

A report describes an experimental investigation of effects of thermally induced intermixing of $In_{0.6}Ga_{0.4}As$ and GaAs on the dynamics of photoexcited charge carriers in $In_{0.6}Ga_{0.4}As/GaAs$ quantum dots. The quantum dots (nanometer-size islands of $In_{0.6}Ga_{0.4}As$ surrounded by GaAs) were grown by metal-organic chemical-vapor deposition. The dynamics at temperatures from 60 to 300 K were investigated by time-resolved photoluminescence measurements with subpicosecond temporal resolution, on both specimens as grown and specimens in which intermixing had been effected by a post-growth anneal. The measurement data were interpreted as signifying that at lower temperatures, the carrier lifetimes in the dots are determined by radiative recombination, which becomes substantially faster after intermixing, while at temperatures >150 K, thermal emission of carriers predominates. Capture of carriers into the dots was found to be fast and governed by carrier-carrier scattering; at room temperature and high excitation intensity, a carrier capture time of 0.72 ps was observed in the intermixed dots. These findings have implications for the development of quantum-dot lasers.

This work was done by Rosa Leon of Caltech for **NASA's Jet Propulsion Laboratory**. *To obtain a copy of the report, "Carrier capture and escape in $In_xGa_{1-x}As/GaAs$ quantum dots: Effects of intermixing," access the Technical Support Package (TSP)* ***free online at www.nasatech.com*** *under the Physical Sciences category.*

NPO-20766

Infrared Sensors for Detecting Icing on Helicopter Blades

It may be possible to detect icing in a single blade pass.

John H. Glenn Research Center, Cleveland, Ohio

Infrared-sensor systems for real-time detection of accretion of ice on helicopter rotor blades are undergoing development. By providing early warnings of icing conditions, these systems would enable pilots to activate deicing equipment or take other corrective action to avoid the severe hazards posed by icing.

The accretion of ice on a helicopter rotor blade begins and is concentrated at the leading edge. Because the freezing process releases latent heat of fusion, the leading edge becomes warmer than the remainder of the blade surface. The present icing-detection technique is based primarily on infrared measurement of the icing-induced variation of temperature between the leading and trailing edges. Secondarily, the technique also involves the use of infrared signatures to determine whether a blade is dry or whether ice has already accumulated.

A system of the type under development includes an upward-staring infrared sensor mounted on top of a helicopter fuselage (see Figure 1). The sensor measures infrared radiation indicative of the temperature profile across the blade as the blade passes by overhead. Experiments have shown that the optimal sensor for this application is a thermoelectrically cooled PbSe photodetector, which is sensitive to radiation in the wavelength range of 3 to 5 μm. A prototype system that has shown promise in experiments includes such a sensor equipped with a germanium lens to focus on a small spot in the rotor-blade plane, plus electronic circuits for

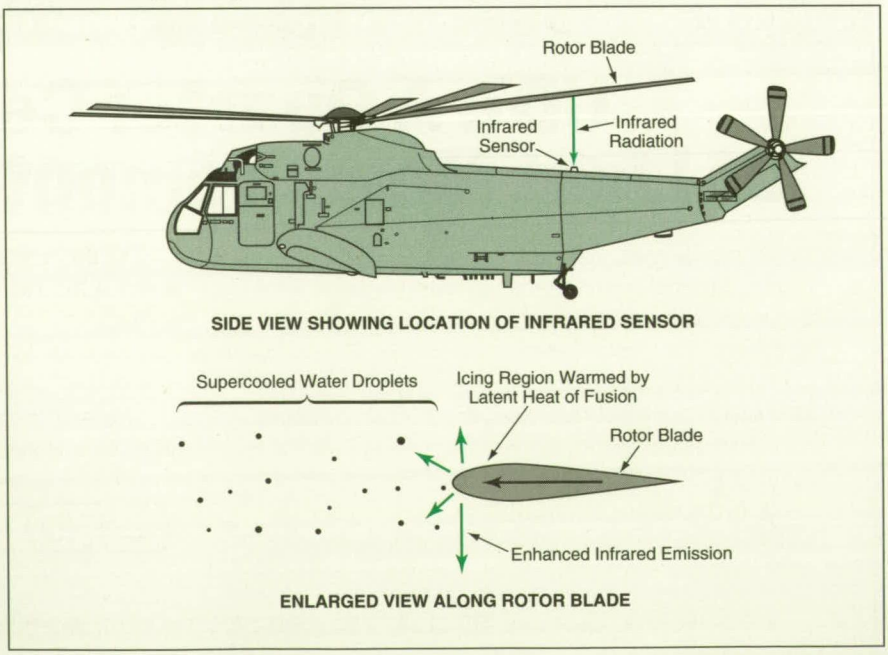


Figure 1. **Infrared Radiation From a Passing Rotor Blade** can be measured to detect a leading-edge temperature rise indicative of icing.

digitizing the sensor readings and processing the digitized readings.

Figure 2 shows infrared-sensor readings taken from three representative helicopter-blade passes during a field test. The curve labeled "Dry" indicates a fairly uniform blade temperature under non-icing conditions. The curve labeled "Icing" was obtained at the commencement of icing caused by the impingement of supercooled water droplets; this curve clearly shows the expected temperature rise at the leading edge. The curve labeled "Static Ice" manifests an apparent cooling of the leading edge after ice had accumulated on the blade but icing conditions were no longer present; this leading-edge-cooling effect is observed consistently under such circumstances and could thus be a basis for detecting ice already present after icing conditions have passed.

The most noteworthy feature of the infrared blade signatures of Figure 2 is that it is apparently possible to distinguish among the three indicated conditions from a single blade pass — an observation time of the order of 2 ms. Even if an ice-detection system employs an algorithm that processes digitized sensor readings from multiple passes to increase the robustness of the decision as to which of the three conditions has been detected, it should be possible to achieve a response time of the order of 1 s.

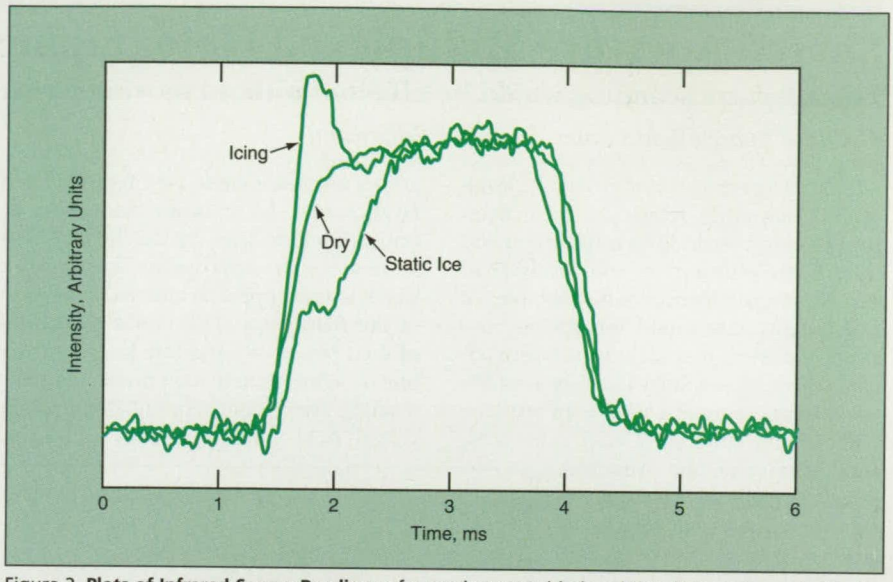


Figure 2. **Plots of Infrared-Sensor Readings** of a passing rotor blade exhibit distinct shapes indicative of the icing and non-icing conditions under which the readings were taken.

This work was done by R. J. Hansman of Massachusetts Institute of Technology and R. J. Rieder and S. Krishnaswamy of Visidyne, Inc., for **Glenn Research Center**.

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16944.

Shared-Aperture Multiplexed Holographic Scanning Telescopes

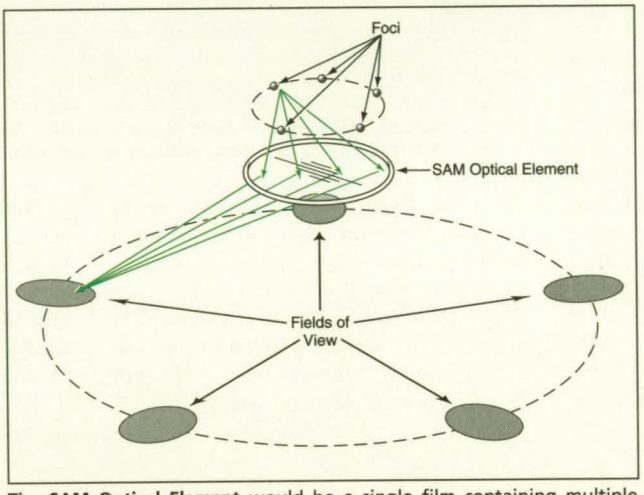
Full-aperture scanning would be effected without moving parts.

Goddard Space Flight Center, Greenbelt, Maryland

Shared-aperture multiplexed holographic scanning telescopes have been proposed for use in lidar transceivers and other laser transmitters and receivers in remote sensing instruments. Examples of instruments that could incorporate the proposed telescopes include airborne terrain mappers, and lidar wind-shear-profiling systems to increase safety of airplane takeoffs and landings. Unlike prior scanning telescopes, the proposed telescopes would contain no moving parts; hence, relative to prior scanning telescopes, the proposed telescopes could be made lighter, more compact, and more reliable.

Instead of conventional reflective or refractive optics, shared-aperture multiplexed holographic scanning telescopes would utilize diffractive optics in the form of holographic optical elements (HOEs). A telescope of this type is said to be shared-aperture multiplexed (SAM) because a number of HOEs would be multiplexed into a single film, the area of which would define a single, shared aperture. Each HOE in the film would be optically addressable by virtue of its angular selectivity, which would define a field of view (FOV) centered on a line of sight different from the lines of sight of the other HOEs. Thus, by optically addressing the various HOEs in sequence, one could aim the telescope sequentially along different lines of sight.

In addition to separate FOVs, the HOEs in the film would have separate field stops, for example, located at various angles around a circle (see figure). Each HOE would be optically addressed by transmitting a laser beam through the HOE along the appropriate line of sight, which would appear to emanate from one of the field stops. This could be accomplished by use of a separate laser for each line of sight. Alternatively, one could steer a single laser beam sequentially through virtual field stops, either by diffractive beam steering mechanisms, or mini-mechanical scanner, or even microeletromechanical systems (MEMS) technology.



The **SAM Optical Element** would be a single film containing multiple HOEs, each of which would provide a unique field of view and focus.

In an alternative optical configuration, the central portion of the SAM optic would be used for transmitting only. In this case, the focal spots from which the laser beam would appear to emanate would be offset from the receiver foci and the central transmitting portion of the SAM optic would no longer be available for receiving. Moreover, in this case, there would be an option to superimpose the receiving foci so that a single detector could be used for all FOVs, provided that the transmitted laser pulses were sufficiently separated in time that lidar return signals would not overlap.

It is worth emphasizing that the proposed telescopes would scan in a step-and-stare mode rather than in the continuous mode of mechanical scanning. Although this may seem at first glance to be disadvantageous, it may not be; indeed, it could even be advantageous. In particular, there is some agreement within the Doppler lidar community that continuous scanning is not needed, and that a step-and-stare approach to gathering data from different look angles may be preferred because it would eliminate the need for lag-angle compensation. (In a mechanically scanned lidar system, the lag angle is a consequence of rotation of a scanner during the time it takes a light pulse from the laser transmitter to travel to the target and back.)

This work was done by Geary Karl Schwemmer of **Goddard Space Flight Center** *and Richard Rallison of Ralcon, Inc. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category.*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Goddard Space Flight Center; (301) 286-7351. Refer to GSC-14240.

Apparatus for Time- and Wavelength-Resolved Spectroscopy

A pulsed electron gun and a spectrometer are combined.

NASA's Jet Propulsion Laboratory, Pasadena, California

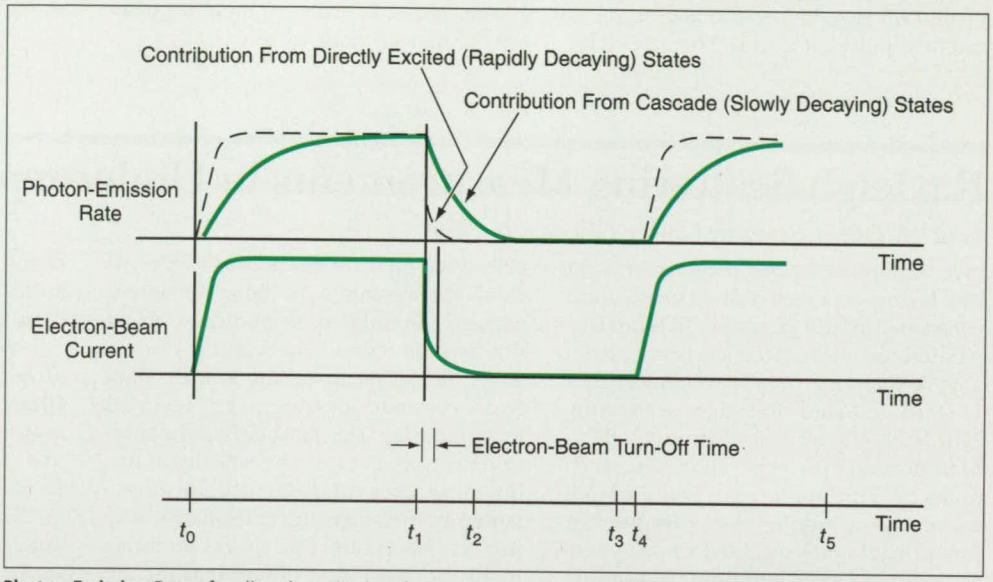
An apparatus that includes a pulsed electron gun and a high-resolution ultraviolet spectrometer has been developed for use in (1) pulsed electron-impact excitation of transitions among the electron-energy states in a gas and (2) measurement of the spectrum of the resulting ultraviolet light emitted by the gas, as a function of wavelength and of time after turn-off of the excitation. The apparatus is designed especially for measuring the Lyman-band emission spectrum of H_2, in order to determine the cascade contribution to this spectrum and thereby to contribute to the understanding of cascade contributions to electron-excited spectra of gases in general.

In the electron gun, electrons are generated by a thoriated tungsten filament and electrostatically accelerated through a collimating magnetic field. The electron beam collides at a right angle with a beam of H_2 or another gas

of interest effusing through a hole. Light emitted by the electron-excited gas is dispersed by the spectrometer, and the spectrally dispersed photons are detected by use of a channel electron multiplier coated with CsI.

A version of the apparatus as described thus far has been used in prior research to excite and measure spectra in the steady state. The present version of the apparatus is distinguished by its capability for pulsed excitation and time-resolved spectral measurement. In the present version, the basic mode of operation, in which the spectrum is measured as a function of time after turn-off of the excitation, is dictated by the following consideration: Directly excited states that decay to the ground state via resonance transitions typically have lifetimes much shorter than those of cascade states; on the basis of this characteristic, it is possible to discriminate against or suppress contributions of transitions between directly excited resonance states and ground, in order to obtain the desired cascade spectrum.

The electron beam is pulsed on and off (see figure) by applying a rectangular potential waveform to one of the accelerating electrodes in the electron gun. Starting at the beginning of the pulse cycle (time t_0), the electron-beam current increases rapidly from zero to a stable "on" value (typically to ≈200 μA within a time of 150 ns). The gun is maintained in the "on" state for a time sufficient to obtain dynamic equilibrium between excitation and de-excitation processes of the specific excited state that one seeks to analyze. At time t_1, the



Photon-Emission Rates for directly excited and cascade states decay at different rates when the electron beam is turned off. One can use this difference to discriminate against the faster decay of the directly excited states to obtain the cascade spectrum.

electron beam is switched off and the electron-beam current falls to zero within ≈30 ns.

After a short gate-delay interval that ends at time t_2, the photon detector in the spectrometer is turned on by use of another rectangular potential waveform. The photon detector is subsequently turned off at t_3, before the beginning of the next pulse cycle at t_4. The gate-delay time ($t_2 - t_1$) can be made long enough that, to a first approximation, the directly excited states can be regarded as having decayed completely to ground. The pulse-repetition period ($t_4 - t_0$), the "beam on" time ($t_1 - t_0$), and the gate-delay time can be varied over a wide range, as needed for analyzing states characterized by effective lifetimes from tens of nanoseconds to ≈8 μs.

This work was done by Joseph Ajello, Dariusz Dziczek, David Hansen, and Geoffrey James of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free online at www.nasatech.com*** *under the Physical Sciences category.*
NPO-20809

Rayleigh-Scattering Measurements in Underexpanded Jets

John H. Glenn Research Center, Cleveland, Ohio

A report describes experiments in which time-averaged and unsteady local variations in the densities of underexpanded supersonic free jets issuing from a choked circular nozzle were measured by laser-induced Rayleigh scattering. This study is part of a continuing effort to understand the generation of screech noise by supersonic jets. The Rayleigh scattering technique used dust-free air for primary and entrained flows, a continuous-wave laser, and photon counting electronics for reliable and accurate measurement. Time-averaged radial density profiles obtained at various axial stations ranging to 10 jet diameters downstream show the development of a jet shear layer and the decay of shock cells. Data on unsteady density variations show the evolution of large turbulent vortices modulated periodically along the flow direction. Comparison of data from these measurements with data from previous measurements revealed the following: The periodic modulation in density and convective velocity of turbulent vortices coincides with the modulation of pressure fluctuations outside the flow boundary. The spatial periodicity of modulation is different from the shock spacing and is associated, instead, with a standing wave. The standing wave is formed between downstream-moving turbulent vortices and the upstream-propagating screech sound waves. It extends from inside the shear layer to the near-field outside the flow. All of these indicate that the sound sources are located a standing wavelength apart.

This work was done by J. Panda of Modern Technologies Corp. and R. G. Seasholtz of **Glenn Research Center**. *To obtain a copy of the report, "Measurement of shock structure and shock-vortex interaction in underexpanded jets using Rayleigh scattering," access the Technical Support Package (TSP)* ***free online at www.nasatech.com*** *under the Physical Sciences category.*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17119.

Back-Illuminated CCDs With Integral Ultraviolet-Pass Filters

Filters would be grown directly on the silicon device's back surface.

NASA's Jet Propulsion Laboratory, Pasadena, California

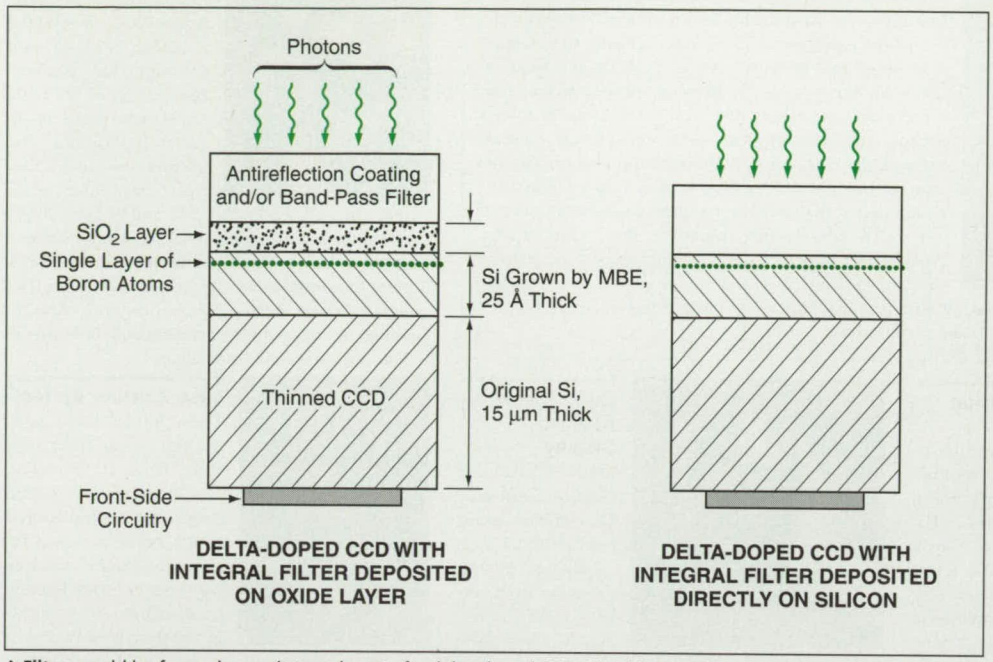
Efforts are under way to develop back-surface-illuminated, thinned silicon charge-coupled devices (CCDs) with delta doping and integral optical filters to be used as image detectors in the ultraviolet wavelength range. The concept of delta doping of back-surface-illuminated, thinned silicon CCDs as part of an overall design to make CCDs sensitive to ultraviolet light is not new in itself. Delta-doped CCDs were invented at NASA's Jet Propulsion Laboratory in 1992, and it is well established that this process produces ultraviolet-sensitive CCDs with stable and uniform 100-percent internal quantum efficiency. The novelty lies in the proposed fabrication of such CCDs in which both delta doping and optical filter layers would be deposited as integral parts of unitary device structures.

Because silicon CCDs are sensitive to visible light, one of the major challenges in the development of ultraviolet imaging CCDs is to satisfy the need for filters that will reject visible light but pass ultraviolet light. Another major challenge is posed by the fact that the naturally-formed SiO_2 on the air-exposed Si surfaces absorbs light strongly at wavelengths <140 nm. Hence, it would be desirable to eliminate the SiO_2 layers as well as to deposit visible-light-rejecting filters and antireflection layers on the back surfaces of the CCDs.

The use of integral filters (as distinguished from external filters that are fabricated on separate substrates) would (1) increase the robustness of image detectors by eliminating the external filters, which are delicate; (2) eliminate the need for structural supports for the filters; (3) eliminate the need for the substrates on which external filters are constructed and which introduce optical losses that degrade detector responses at short wavelengths; and (4) reduce the number of optical surfaces, thereby reducing overall optical losses by eliminating the loss (typically at least 2 to 3 percent) associated with each such surface eliminated.

Because the delta-doped layer lies permanently ~5–10 Å beneath the back surface of a CCD, the delta doping process does not pose an impediment to the subsequent deposition of optical filters and antireflection layers. The problem then becomes one of depositing these optical layers directly on the silicon surface, without the formation of an intervening SiO_2 layer. The approach taken in the present development effort is to perform delta doping in one ultrahigh-vacuum molecular-beam epitaxy (MBE) chamber and

then, without breaking vacuum, transfer the CCD to a connected metal/insulator MBE chamber wherein the filter layers are deposited. By refraining from breaking vacuum until after the deposition of the filter layers, one can prevent the formation of the SiO_2 layer (see figure). At the time of reporting the information for this article, MgF_2 antireflection layers optimized for the wavelength range of 200 to 300 nm had been deposited on delta-doped CCDs and were found to result in a modest increase in the quantum efficiency of the CCDs at a wavelength of 180 nm.



A **Filter** would be formed as an integral part of a delta-doped CCD. The filter could be deposited on the back-surface oxide, but it would be preferable to prevent the formation of the oxide and deposit the filter in direct contact with the silicon.

This work was done by Shouleh Nikzad, Peter Deelman, Paula Grunthaner, Frank Grunthaner, Michael Hoenk, and R.W. Terhune of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Systems category.*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

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Refer to NPO-21007, volume and number of this NASA Tech Briefs *issue, and the page number.*

New Products

For more information on the products below, go to www.ptbmagazine.com/products.

Product of the Month

Machine Vision System for Fiber Ends

Cognex Corp., Natick, MA, has introduced FiberInspect™, a machine vision system designed specifically to automatically locate and measure scratches, cracks, and spots on fibers that form during the polishing process of the ends. FiberInspect can detect fiber end defects smaller than a micron, the company says, even when image contrast between the defect and the background is poor. The system can be used with existing manual inspection systems or integrated by OEMs into custom-designed automated systems. Besides cutting inspection time, Cognex says, FiberInspect improves upon manual inspection because the latter is subjective, and operators may pass defective cable that may fail later. The system consists of advanced machine vision inspection software, a Cognex MVS-8100 framegrabber, and a Windows®-based graphical user interface.

High-Precision Prisms

Edmund Industrial Optics, Barrington, NJ, offers a new series of what it calls extreme-precision prisms at angle tolerances as small as ±1 arcsecond. The line includes a wide variety of roof and penta sizes to complement the other prisms in the Edmund inventory. Current capabilities include hundreds of styles and sizes, such as equilateral, dove, dispersion, right-angle, micro, trihedral, and more. Additionally, the company is offering a news series of dichroic beamsplitters. These components are available in uncoated versions and with standard coatings, including antireflection and aluminized faces.

Radiometer/ Photometer System

International Light Inc., Newburyport, MA, says that its IL1700 research radiometer/photometer has a proprietary front-end amplification system that enables it to operate over a 10-billion-to-1 dynamic range while maintaining 0.1-percent linearity. It is available with a wide variety of standard detector and filter combinations for measuring from the UV through the IR. The instrument can store 10 calibration factors in memory, and can provide direct reading in any optical unit. It is capable of autoranging during exposure from moonlight to direct sunlight. It is calibrated in NIST-traceable units.

CCD Camera for Digital Microscopy

Roper Scientific, Tucson, AZ, has released the Photometrics CoolSNAPcf™ color imaging system designed for digital microscopy. The camera is based on a cooled 1392-×-1040-pixel CCD whose low-noise electronics enable high-resolution images at 20 MHz, the company says. The system has proprietary Primary Point Digitization™, eliminating the need for an external control unit or power supply. The camera's standard C-mount provides compatibility with commonly used research-grade microscopes.

Laser Power Analysis Display

Coherent's Auburn Division, Auburn, CA, combines handheld personal digital assistant (PDA) devices with its laser power SmartSensor™ technology in a new line called LaserPAD, for laser power analysis display. The company says that with a choice of more than 25 NIST-traceable calibrated SmartSensors, accurate power measurements can be easily and quickly made for laser, diodes, and fiber optics. Coherent says that the PDA provides optimum data processing, storage, and display of results.

Front Surface Mirrors

Abrisa, Santa Paula, CA, is partnering with Glass Troesch of Switzerland to distribute a line of front surface mirrors. Glass Troesch is expanding its product line offering of Luxar™ antireflective coatings to include reflective front surface mirrors in thicknesses of 3, 5,and 6 mm, in a sheet size of 74 × 110 in. The FSM94-X is described as a durable, high-performance broadband mirror with a reflectivity of 94 percent. It is an aluminum mirror enhanced with a multilayer dielectric overcoating, improving visible reflectivity by 7 to 9 percent over standard aluminum mirrors, Abrisa says.

Fixed Abrasives

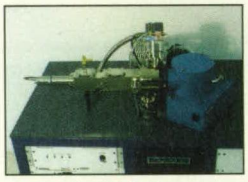
Gator Diamond Inc., Winter Springs, FL, offers a line of diamond impregnated fixed abrasives, or pellets, that has been demonstrated not to go through the normal decay of material removal rate (MMR) that is characteristic of other fixed abrasives. These devices, called self-dressing or low-load fixed abrasives, have been proven on many materials, such as glass, ceramics, sapphire, silicon, and quartz, according to the company. Gator Diamond has also patented a technique for arranging an array of pellets with differing properties onto a lapping plate so that the resulting wear is considerably more planar than with competitive methods.

High-Power Nd:YAG Laser Optics

Acton Research Corp., Acton, MA, is making available mirrors and coatings for Nd:YAG lasers designed for high-repetition-rate, high-power applications. The mirrors come in Nd:YAG laser harmonic wavelengths, including 532, 355, 266, and 212 nm. Acton says the 266-nm mirror coating has produced impressive damage threshold figures, withstanding 5-7 J/cm² at normal incidence on SiO_2 substrates. The company offers high-performance antireflection coatings for the Nd:YAG fundamental 1064 nm as well as the harmonics listed above.

Laser Cutting System

The QuikLaze-50™ laser cutting system from New Wave Research, Fremont, CA, is a compact pulsed single- or multiple-wavelength device designed for microelectronics machining. With its repetition rate boosted from 40 to 50 Hz in this third generation of the system, the company says, QuikLaze-50 offers electronics manufacturers increased throughput for a variety of micromachining applications. The system makes uniform repeatable single-shot cuts from 50-×-50 micrometers to 1-×-1 micrometer. Wavelengths of 1064, 532, and 355 nm, or of 532 and 266 nm, are selectable.



Atomic Emission End-Point Detector

McPherson Inc., Chelmsford, MA, says that its windowless discharge lamp, operated with helium as a carrier gas, provides a clean background that allows the introduction of secondary or sample gases from process chambers or other sources. This permits the analysis or monitoring of gaseous nonmetals such as fluorine and chlorine. When coupled to a McPherson vacuum monochromator with suitable vacuum pumping, the system can detect emissions anywhere from 30 nm in the UV to the visible spectral region. The company recommends the instrument for end-point determination of CVD chamber cleaning.

Molded Plastic Photonics Components

Matrix Inc., East Providence, RI, introduces custom engineered components molded from a wide variety of engineering plastics. They include optical subassemblies with integral lenses and microlens arrays with 250-micrometer centers. They have 4-micrometer tolerances on a 2.5-mm hole, ±15-micrometer concentricity, and positional tolerances of ≥3 micrometers, depending on size and material. Produced from materials such as Ultem®, Fortron®, PEEK, and LCPs, the components can range in size from <3 mm diagonal by <4 mm, with diameters down to 125 micrometers and walls as thin as 0.5 mm.

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Simplifying Communication with CAD and Collaboration Tools

Your company has decided that it needs to invest in collaborative engineering tools in order to improve communications, increase productivity, speed time to market, and reduce costs. That's great, but now what? Do you look for CAD viewing and markup tools? CAD-related application service providers (ASPs)? Product data management (PDM) software? Should you choose completely Web-based applications? There are a lot of options, and a lot of chances for your company to spend a lot of money on the wrong products.

Taking advantage of collaborative engineering has transitioned from being a competitive advantage to a competitive necessity, according to Chuck Giarratana, director of North American Consulting Operations for CIMdata, the research and consulting firm that hosts a Collaborative Engineering Through the Supply Chain conference each year. "It's not a matter of if you take advantage of these technologies," he said, "it's when and how. And I would suggest the time is now for a growing number of companies to make their move in investing in these solutions."

CIMdata president Ed Miller wants companies to have a clear vision of what to invest in based on their individual needs. A grave mistake many organizations make, explained Miller, is that "they narrowly focus on technical details and system capabilities such as storage capacity and file transfer before they identify why money is being invested in the system in the first place."

Defining Collaboration

It's no secret that collaborative engineering tools are being bought at a growing rate — CIMdata estimates spending will exceed $4 billion this year. So what, exactly, are these tools? Market research firm Daratech defines collaboration tools as those that provide some form of real-time interactive viewing, interrogation, markup, and sharing of engineering models, drawings, and related information. Most of these tools leverage the Internet or an intranet, and don't require access to the CAD system with which the data was authored.

"People use the word 'collaboration' when a more appropriate word may be 'communication,' which is far more descriptive," said John McEleney, chief operating officer of SolidWorks. "In terms of collaboration, we may be on the verge of the greatest market that never happened. Markets like these tend to get over-hyped and quite frankly, under-defined, because they tend to mean everything."

According to McEleney, the struggle for engineers today is how they get information to the people who need to have it. The world of communication is hard enough when it's just 2D, but when you talk about 3D, it's even more difficult, he explained.

Santanu Das, vice president of engineering technology for netGuru, agrees that collaboration is an overused word. "Some people have kind of bastardized the terms 'project management' and 'collaboration.' The pure sense of the terms has been diluted." netGuru is the parent company of Web4, which offers Web4engineers.com and eReview Web-enabled workflow sharing applications.

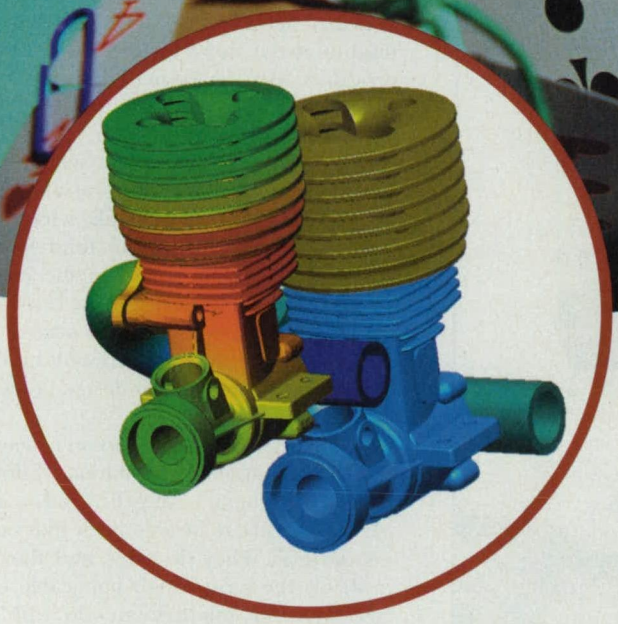
"A lot of companies consider collaboration to be anything from document management to an on-line storage repository," said Das. "Our definition of collaboration is a true, real-time system of communication where multiple people at one time can express their views in real time."

Somewhere in between e-mail and interactive design is where Andrew Anagnost, director of industry marketing and product development for Autodesk's Manufacturing Market Group, sees collaboration residing. "What's important to focus on is not just the actual moving of files, but how the information is being used. It's all about sharing information with a purpose — finding a problem and cutting the cost."

Anagnost points to NASA's Jet Propulsion Laboratory, an Autodesk customer that he feels is on the cutting edge of collaboration. "They are right where I think our customers will end up," he explained. The lab has a room where several designers engage in collaborative sessions for up to three hours at a time with remote vendors and subcontractors. They discuss and identify issues, and propose solutions in real time to the problems. "They can get the problem solved before the product gets built," said Anagnost. "That's really what collaboration is about. It's catching problems early and helping people understand what the issues are in developing a product at all stages."

Choosing a Solution

Selecting collaboration tools is not governed by a specific set of criteria. "Right now, companies are experimenting to see which tools make the most



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sense," according to Paul Bemis, vice president of eBusiness for ANSYS. "What we have is an immature market." The most important thing is for companies to decide what type and how much collaboration they need to do.

"Companies have to distinguish what collaboration means to their productivity," said Dr. Yuri Kizimovich, president, CEO, and co-founder of 3Ga Corp., which provides a Web-native engineering collaboration service called 3G.web.decisions. Developing a basic strategy begins with defining how collaboration will be implemented, who will participate, and if real-time interaction is critical.

"Once you have that strategy in place, you can start correlating those elements with products," said Alain Danik, director of business development for Cimmetry Systems, which offers the AutoVue viewing and markup tool. "If you don't need synchronous collaboration — that is, real-time or near-real-time — then you may choose a viewer for collaboration. If you need real-time collaboration, a viewer may not be your best choice," he explained.

McClure agrees that choosing the right tools is a function of a company's needs and their design process. "At what level does their process require interaction? They may have a process where a supplier/customer relationship requires reviews, but only one party is making changes. There may be dispersed design teams where both teams are interactively changing the design," McClure explained.

The size of a company also comes into play for various reasons. Said Das, "Some of our larger customers use our products just for the Web-based applications. They have so many offices around the world, they have so much trouble managing their software, or they don't have the latest version in one office — so they have to centralize their applications." Bigger companies, he explained, can afford to provide the initial investment in collaboration tools that they know will pay off in the long run. Smaller companies can't afford to put that investment down.

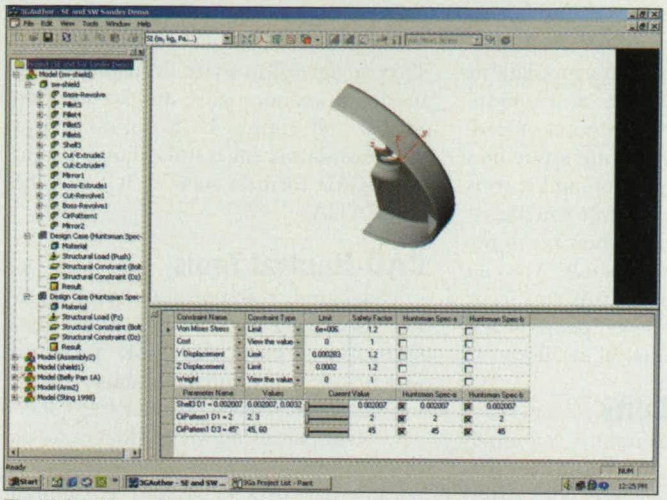
Bemis agrees that larger companies tend to go for more established solution providers. "An old adage in the computer business was that you can't lose your job for buying IBM," Bemis said. "A similar case can be made for Dassault Systemes in our business. 'Let Dassault solve all of our problems for us, and we'll take what they give us.' Larger companies tend to do that." Smaller companies, on the other hand, are less interested in a one-stop shop for all their needs, according to Bemis. They're more interested in the technology itself and their design process, to see which one fits.

Regardless of size, Das doesn't believe there's a one-tool-fits-all solution. "I don't think any company can get by with a single tool. I'd like to be able to say that viewers do it all. They do a lot, and they're probably the most widely applicable collaborative tool, but they can't do it all."

What's on the Market

Once a company has determined its collaboration needs and the types of tools required, it's time to go shopping. Whether it's a CAD-based product, an ASP, a viewing and markup tool, or a combination of all or some of them, there are a lot of offerings to choose from.

CAD vendors such as UGS, SolidWorks, PTC, SDRC, and Autodesk provide a choice of collaboration options. UGS, for example, has introduced Solid Edge Exchange, a collaboration portal that's powered by the company's e-Vis visual collaboration technology, and incorporates the Solid Edge CAD features. The two provide a common repository of information so that everyone working on a project has the same data. Solid Edge Exchange also features interactive conferencing and visualization of 2D and 3D product data.



The Web-native environment of 3G.author is part of 3Ga's 3G.web.decisions. A copy of the 3D model is imported from the native CAD system, but you don't need any CAD system on your computer to use 3G.author.

SDRC offers I-DEAS Enterprise, a collaboration application that manages design data and supports teams located all over the globe. It combines the company's I-DEAS mechanical design automation software with its Metaphase product knowledge management technology. PTC also builds on its already established technologies to provide Windchill Netmarkets, through which on-line exchanges can deliver Web-based project services that facilitate collaboration among manufacturers, suppliers, and customers.

Autodesk has launched two different collaboration services, each with its own objective. Point A is an information repository that lets people share bits of industry-generic information, not necessarily product-development information. The other service, Streamline, attacks the entire information-sharing requirement of the product lifecycle, according to Anagnost. "We do that by making the entire product available on-line, without copying it. People do not receive a drawing via e-mail. They never own the information, yet they have full access to it." The biggest problem with many Web-based collaboration tools is mistaking an older version of a file for the latest version. "People send out drawings and somebody thinks the drawing is final when it isn't," Anagnost explained. "It happens all the time."

With Streamline 2, which just went live last month, Autodesk has added a Publishing Wizard that lets users create a "Publish to Streamline" folder on their desktop. Every time they save CAD information or change CAD information in that folder, it automatically publishes the information up to a Streamline site where people can share the information. With Streamline, though, users never really put the CAD files up, explained Anagnost. "They publish to Streamline. What that does is break the CAD information up into a bunch of little XML snippets, which are stored on Streamline and served out to people, bit by bit, on a secure server. No one can use these bits of information to recreate the CAD file. It just isn't there."

SolidWorks also offers a choice of collaboration tools. 3D Instant Website lets users create and publish live Web pages with SolidWorks models and drawings. eDrawings are small enough to e-mail, are self-viewing, and don't require viewers to be downloaded.

e-CAE.com is an application service provider program available from ANSYS that allows users to run their simulations on parallel compute servers at a remote data center site using the Internet or dedicated lines. "You create your input files and send them to this server, and it runs full ANSYS on it — any module you like — on a pay-as-you-go basis. When it's done, the results are there," said Bemis. "You can either download them or you can leave them there and let other people view them from different physical locations."

CAD Interoperability

The design chain, by nature, is a multi-CAD environment, according to Kizimovich. Therefore, CAD companies don't want to develop interoperability tools to another CAD system because they simply don't want to give the competition an advantage. So where does that leave the members of a supply chain who don't all have access to the same CAD package?

According to Bemis, interoperability is becoming less of an issue over time. "On the simulation side, we've had to deal with interoperability for years. We're an independent solution provider, so we can read all of the CAD geometry. Often, we can even pick up their associativities and bring them over, too."

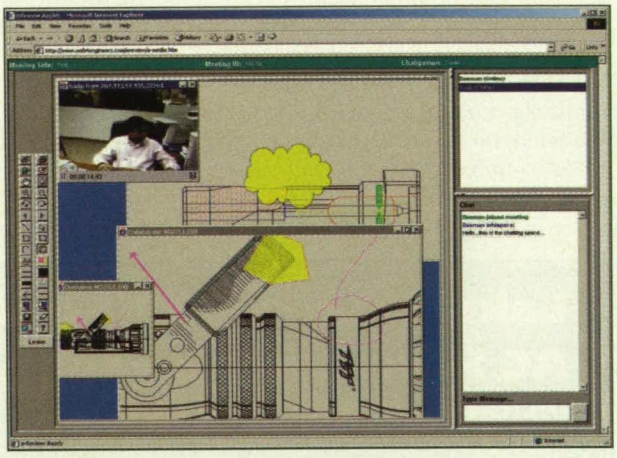
Interoperability also becomes less of an issue if you don't need to modify geometry, explained Danik. "If there's a requirement to modify geometry in a collaborative context, then obviously viewers won't do that for you, and CAD translators won't do that for you. You need to be able to move the data from one CAD system to another."

CAD translation services are available, such as those provided by Translation Technologies, a Spokane, WA-based company that delivers feature-based, native CAD file translations. The service enables engineers to pass fully functional files between major CAD systems via a secure Internet connection transmitted to and from TTI. The translated file is delivered in the desired CAD system, with all of the geometry and a history tree that lets users operate in the file as though it was created in the target system.

Soon, interoperability may not be an issue at all. Spatial and UGS, makers of the ACIS and Parasolid modeling kernels, respectively, have agreed to work together to improve 3D data interoperability. They've agreed to share licenses for their modeling technologies, and in addition, Spatial will supply UGS Parasolid with data translators for standard and proprietary CAD formats such as IGES, STEP, and CATIA.

CAD-Neutral Tools

Web-based collaboration services, as well as viewing and markup tools, don't focus on a particular CAD program, which makes the interoperability issue a moot point. Services such as 3Ga's 3G.web.decisions allows engineers to use their Web browser to access and reuse parametric CAD data, and collaborate and instantaneously validate a design. From a common URL, any member of a design team can simulate how parametric engineering changes will impact the fit, form, and function of the design.



Web4's eReview combines a way to conduct on-line meetings with the ability to view and annotate over 150 documents, drawings, and CAD file formats in real time over the Internet.

CoCreate's service, OneSpace, is built as a "virtual conference room." It provides a CAD-neutral environment in which users can work with models from all major CAD systems and 2D files — more than 300 file formats in all. Design teams can schedule and enter a design session, resolve design issues, and automatically document changes in the session. Teams collaborate in real time, and have access to the product information, the model, and all of the associated data.

Web4's products — eReview and WebWorks — also take advantage of on-line meetings and data access. eReview combines a way to hold meetings and share documents live, over the Internet, with the ability to view and annotate documents, drawings, and CAD files in over 150 formats. Geographically dispersed team members can collaborate on design decisions or other activities that require all attendees to view the same set

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of drawings and share their ideas. WebWorks allows users to create a central repository for their files, documents, and drawings.

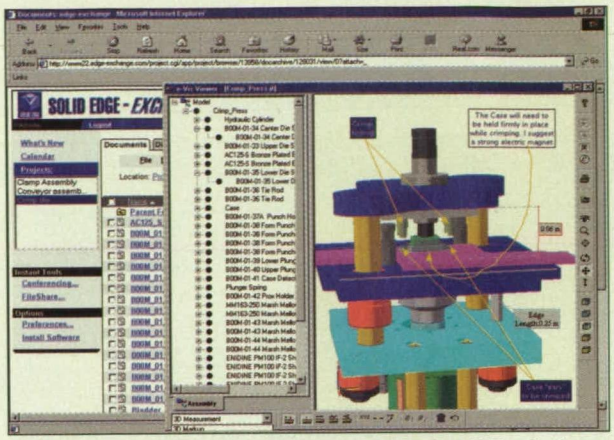
Proficiency's Collaboration Gateway is a Web-based application that runs on standard Web browsers, enabling communication of engineering information between and among suppliers and manufacturers. It extracts design intelligence from proprietary CAD systems to the Universal Product Representation (UPR), a system-neutral format for representing design intelligence. Information can then be shared between team members, regardless of their internal process or systems.

One of the most widely used types of collaboration solutions is the viewing and markup tool, which enables engineers to collaborate with other team members who use different software. Files and drawings created in various CAD systems can be viewed and shared by users around the world.

According to Danik, Cimmetry Systems' AutoVue viewing tools are used at every step of the design and manufacturing process, including product definition, maintenance, purchasing, marketing, sales, and even litigation. "In all of our applications, when you open a file, you open it in read-only mode. The original can't be edited, either willfully or inadvertently." This is why viewing tools carry the lowest risk of all collaboration solutions.

Actify's 3DView also enables engineers to visualize, share, measure, and markup 3D CAD models without requiring a full-featured CAD system or server. It reads native CAD formats directly, and can visually mix and match parts together from different CAD formats. 3DView also lets you publish CAD models on a Web site, and keeps track of notes and dimensions assigned by different people.

Brava!, from Informative Graphics, is a Web-served viewing tool that uses Java technology. Documents and drawings are processed on the Brava! server and delivered in a compressed display format viewable only by a Brava! client server. Original files are never sent, so CAD drawings and intellectual property can't be copied.

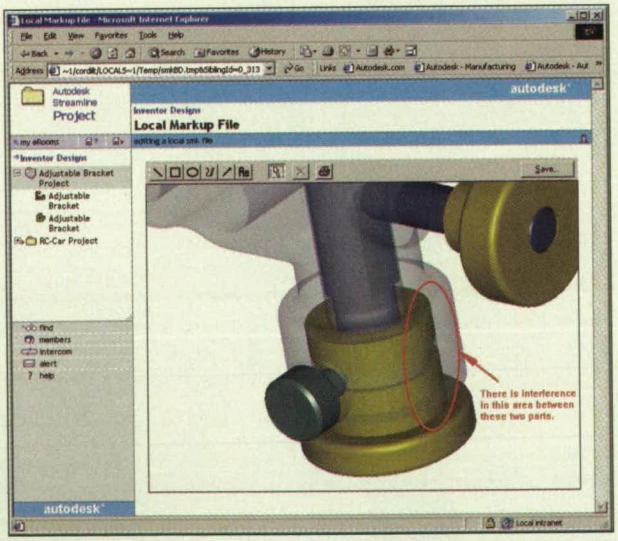


A collaboration session on a solid model in UGS's Solid Edge Exchange shows redline markup and measuring capabilities.

Ease of Use

Collaborative engineering may begin with the engineer when he or she first designs a product using a 2D or 3D CAD system. But what happens when that data has to be filtered down the supply chain to purchasing, marketing, sales, and customer support? How equipped are other members of the team to use collaborative tools effectively? For the people further down the design chain, ease of use is absolutely essential, said UGS's McClure.

Autodesk's Anagnost agrees. "Ease of use is a significant concern. In fact, I think the entry point of a collaboration tool has to be extremely simple. If these tools are too complex or give them more information than they need to do their job, they will not use them." The key, said Anagnost, is personalizing the design information to the purchasing manager, or whoever the user happens to be, so that each user sees only what they need.



Autodesk's Streamline 3D markup functionality lets users indicate design changes that can be communicated back to the designer and other team members via an automatic e-mail notification.

By doing that, said Das, you're able to accommodate each user individually. "I think you need proper Web collaboration tools that have a good administrative control facility that allows an administrator to customize the interface and the tools available as you work down the chain." And, depending upon the engineering discipline, it could also take some time for engineers to embrace these technologies, Das added. "Usually engineers are known to be more conservative than other professionals in other industries, and they're actually typically much older and less trusting of Internet-based technologies."

Explained McEleney, the idea of people being able to easily share information just because they use the same CAD system is a prehistoric view. "You can imagine some ridiculous high-end UNIX CAD system being on a purchasing guy's desk and the only thing he wants to be able to do is catch a glimpse of what the part looks like. Most of the people who need to be able to view information have nothing to do with CAD, and don't want to do anything with CAD. They just want to see what the thing looks like."

McEleney said that SolidWorks' latest collaborative tool, 3D TeamWorks, attempts to simplify communication and information sharing. "We've tried to make these crayon-simple tech tools to allow users to very easily and effectively get on the on-ramp of being able to share information," he said. 3D TeamWorks is a hosted project facility area that allows project personnel and other users to have a central repository for data, and to be able to share comments and review-type information. "It's not meant to be PDM," added McEleney. "It's meant to provide some way of taking rather disparate ways of communicating — including e-mail, eDrawings, Instant Websites, engineering drawings, 3D solid models, faxes, and schedules — and allowing this to all be in a central repository area."

For Web-based collaboration services, ease-of-use may be less of an issue, according to Kizimovich. If you can use a Web browser and have a reasonable knowledge of Windows, the rest is easy, he said. "You're launching a browser and typing in a URL, which everybody

can do. You just need the basic knowledge of how to use a browser, how to search, and how to navigate Web pages. It's not likely that a marketing department will change a model. They just want to see it."

The more broadly applicable the collaboration tools are, the better. The trick is how well CAD vendors and others providing these tools understand what the marketplace is looking for in terms of capabilities. According to Das, CAD companies have a long way to go. "The problem I see is that it's really not the CAD companies' core competency to develop collaboration-based tools. What they're really good at, and what they should be supplying, is CAD. Autodesk could also make chewing gum if they really wanted to, but it probably wouldn't be in their best interest."

Das suggests that CAD companies partner with others who can provide them with the technology to integrate with their CAD packages to enable collaboration. "I personally think," said Das, "that the CAD vendors who spend money to provide Web-based collaboration tools that integrate with their products will see that it's a detriment to their overall product."

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Commercialization Opportunities

The Wireless Augmented Reality Prototype Concept

This is a system of personal access to a local area network with video, audio, and sensor data services. Head- and belt-mounted units would enable wearers to communicate data while moving around a busy facility.
(See page 44.)

MQW Based Blocked Intersubband Detector for Low-Background Operation

Multiple-quantum-well (MQW) infrared photodetectors are better suited for operation under low-background conditions. Large focal-plane arrays of these detectors should be relatively inexpensive.
(See page 46.)

Airfield Wind Advisory Systems for General Aviation

These systems include self-contained weather stations located at the airfields. Speed and direction of wind, temperature, barometric pressure, and humidity are transmitted to the aircraft on a landing approach.
(See page 50.)

Lightweight, Collapsible Hyperbaric Chamber With Airlock

Such a chamber can be stowed compactly and deployed when needed as rescue equipment in remote locations.
(See page 54.)

Reconfigurable Exploratory Robotic Vehicles

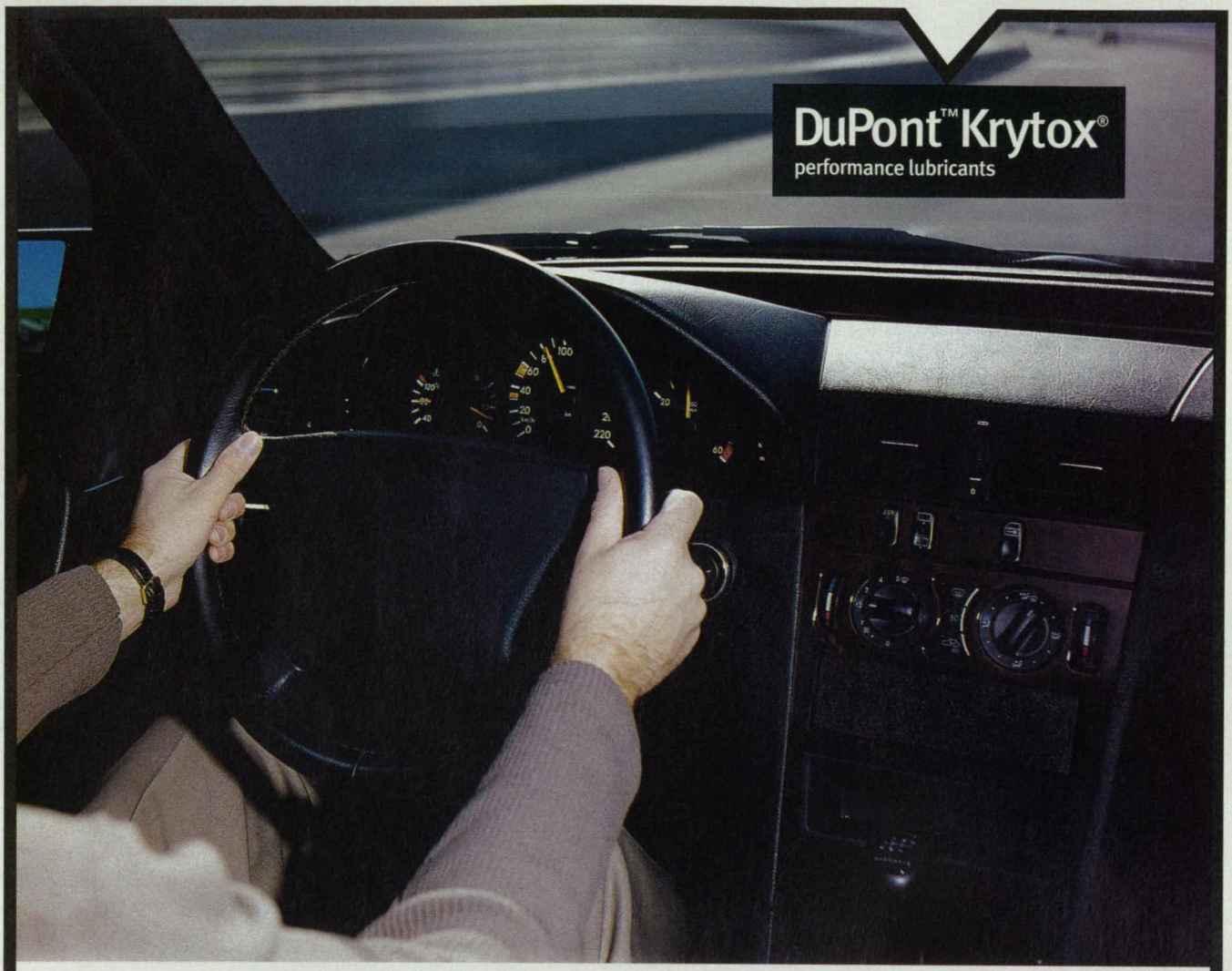
A family of rugged, modular, instrumented robotic vehicles proposed for exploration of Mars and other planets can be adapted to explore hostile terrain on Earth. Application may involve exploration of volcanic craters, military reconnaissance, and search for victims of earthquakes, landslides, and avalanches.
(See page 56.)

Engineered Bioremediation of Contaminated Soil

This computer-controlled process controls flows of liquids and gases into and out of the ground via wells to provide reagents and nutrients that enhance the natural degradation of contaminants by indigenous and/or introduced microorganisms.
(See page 58.)

Microgravity Tissue Engineering

Cartilage and cardiac muscle can be engineered for research in normal gravity and microgravity. The current program has used cells, polymer scaffolds, and bioreactor vessels. Successful development in this area can have major impact in the treatment of aging population, trauma victims, and crews on prolonged spaceflights.
(See page 59.)



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Coherent Phase Line Enhancer: a Method of Spectral Analysis

This method enables detection of weak signals that would otherwise be masked by noise.

Marshall Space Flight Center, Alabama

The term "coherent phase line enhancer" (CPLE) refers to a dual-transform method of spectral analysis that enhances the detection of periodic and quasi-periodic signals buried in wide-band noise. The CPLE is particularly useful for increasing the signal-to-noise ratios of spectral peaks ("lines") that represent periodic and quasi-periodic components of measurements of vibration, dynamic strain, and/or dynamic pressure in a turbine or other rotating machine. The purpose of such measurements, spectral analysis, and enhancement of spectral peaks is to assess machine performance and identify spectral signatures of bearing or gear-train defects.

Other machine-diagnostic spectral-analysis methods related to the CPLE have been described in several prior articles in *NASA Tech Briefs*. The need for the CPLE and those other methods arises, in part, because in conventional spectral displays, peak patterns are frequently difficult to assess in cases in which peaks are at or below the amplitude of wide-band noise. ["Conventional spectral displays" as used here denotes those produced by fast-Fourier-transform (FFT) processing of digitized signals.] In such displays, periodic signals may not be separated from wide-band noise because the phase information needed to show the peaks for these signals is missing after FFT processing. The CPLE involves a second transformation that restores the needed phase information. In addition, in the CPLE, the discreteness of each spectral component is quantified by a bandwidth coherence value.

The traditional method of estimating the auto power spectral density (PSD) function involves ensemble processing of the FFT amplitude of each segmented data block and discarding the FFT phase information. The resulting "ensemble amplitude averaging" PSD function is widely used in many commercial test and measurement products. For the purpose of separating a periodic signal from noise, additional signal-enhancement capability can be achieved by including phase-correlated information in the ensemble processing. After the original signal is transformed from the time domain to the frequency domain, the spectral record consists of an ensemble of blocks. In the CPLE, a second transform converts each spectral component along the ensemble direction into an "equivalent" wave-number domain, in which signal components are enhanced by virtue of their coherent phase relationships among the ensemble segments.

In comparison with spectrum obtained by FFT processing only, a CPLE spectrum provides a more accurate estimate of the frequency of a periodic signal. Moreover, the difference between the coherent phase characteristic of a periodic signal and the random phase of wide-band noise is more apparent in the wave-number domain. As a result, in comparison with a conventional power spectrum, a CPLE spectrum enables better detection of periodic signals. Unlike some other filtering techniques (e.g., adaptive filter, adaptive line enhancer, and the like) used to enhance signals, the CPLE can be the basis of a relatively simple and stable approach that can be easily implemented in the frequency domain along with the FFT.

The quasi-periodicity (as distinguished from pure periodicity) of the vibration signal from a typical rotating machine poses a major obstacle to the direct application of the CPLE to analysis of these signals. The rotation-speed-related components of the signal (e.g., synchronous harmonics and subharmonics, bearing signatures, gear signatures, and the like) are all quasi-periodic because rotation tends to momentarily accelerate or decelerate as the load on the machine varies. A direct application of the CPLE to the signal does not provide any enhancement because only weak (if any) coherent phase relationships exist among the ensemble segments. However, one can obtain the desired enhancement by following either or both of the following two approaches:

The first approach is called "CPLE/OT" (where "OT" signifies "Order Tracking method"). This method requires an additional pulse tachometer (key-phasor) signal. Measurement of the time between the pulses yields an instantaneous value of the rotation period once per revolution. On the basis of this measurement, the original digital signal, which is sampled at uniform intervals of time, is then resampled with a fixed number of samples during each revolution. The resampling involves the use of either linear interpolation or (in the case of large variations of speed) spline-curve-fit interpolation. The resampling is utilized in the conventional synchronous timer averaging (STA) method. STA enhances a waveform through direct time averaging of the resampled waveform over many revolutions. Within the resampled signal, all the speed-related components are periodic. Therefore, CPLE spectral analysis is applicable to speed-related signal enhancement.

The second approach is called "CPLE/PSEM" (where "PSEM" denotes "phase synchronized enhancement method"). This method does not require the key-phasor signal. The PSEM involves a phase-to-time conversion algorithm that transforms the instantaneous phase of a reference component of the signal into the desired resampling time for synchronization. (The reference component is selected by the user and is typically synchronous with either the rotation or a harmonic thereof.) Within the resulting PSEM signal, both the reference component and all its coherently correlated components become periodic. Consequently, when CPLE spectral analysis is applied to the PSEM signal, enhanced results are obtained.

This work was done by Jen-Yi Jong of AI Signal Research, Inc., for **Marshall Space Flight Center**. *For further information, please contact the company at www.aisignal.com or (256) 551-0008.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center; (256) 544-0021. Refer to MFS-31426.

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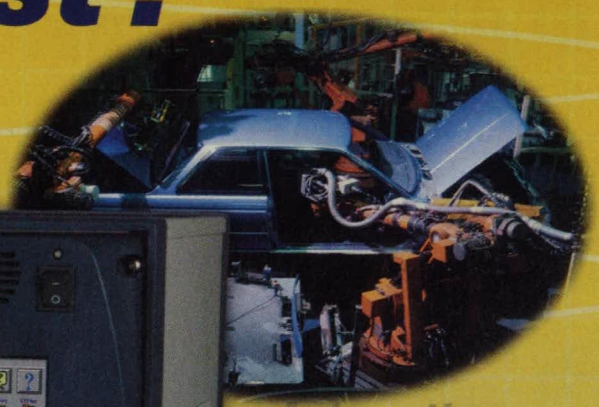
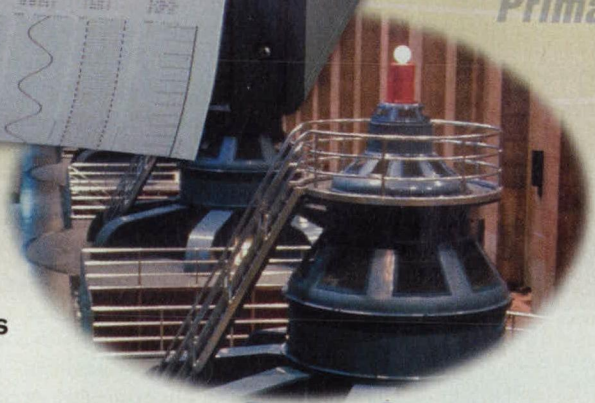


Automotive

Primary Metals



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Software for Secure Distribution of Data

Many users at remote locations can work on the same set of data.

NASA's Jet Propulsion Laboratory, Pasadena, California

MECS is a computer program for the automated, secure, rapid, and efficient transfer of data between a central source and users at multiple distant locations. "MECS" signifies "Multi-mission Encrypted Communication System." MECS enables many users to collaborate securely on a shared plan or set of data.

MECS was part of the Mars polar lander mission operations environment, and enabled for the first time in NASA's history, distributed operations over the Internet during a mission operational readiness test. It has allowed remote scientists to lead field tests of the FIDO rover, which is the prototype for the Mars '03 rover.

MECS transfers data from a mission control center to remote users, and from the remote users back to the mission control center. MECS is designed to work with previously developed mission application programs that, in their original forms, do not support secure distributed operation; MECS can often enable secure distributed operation with little or no modification of the previously developed application programs. MECS operates in such a way as to be transparent to a remote user. Files simply appear on the remote user's computer as they become available, and files are transmitted back to a server computer at the mission control center when the user saves them in specific directories.

All MECS connections are authenticated by use of the NASA public key infrastructure, and all communications are encrypted by use of the Secure Sockets Layer (SSL) protocol. It is nearly impossible to decipher intercepted data that have been transmitted via MECS, and in order to defeat the authentication protocol, it would be necessary to compromise the NASA Ames Certificate Authority, which is highly protected. A copy of the MECS client software cannot be activated unless the remote user to whom the copy has been assigned presents a personal security profile that is kept on a floppy disk in the possession of the user. To obtain a security profile, a remote user must appear in person and provide positive identification at a security office at a NASA center. The NASA public key infrastructure handles the periodic updating of users' security profiles and protects the central certificate authority.

MECS is implemented as two Java programs. For each mission, there is typically one server program operating on a computer behind the mission firewall, and many client programs, each running on a remote user's computer. The MECS administrator indicates which files should be received by the remote users, and the MECS clients automatically download the data as it becomes available. All data is compressed and encrypted while in transit, and is automatically decompressed and moved to the proper locations on the client's computer.

Each remote user starts the MECS client program and specifies the address of the MECS server. The MECS client and server programs authenticate each other, and then the client program transmits the current state of the remote user's data base to the server. The server then transmits all of the files necessary to bring the remote user's data base up to date. Periodically, the MECS client program automatically communicates with the server to determine whether new data have arrived.

In its original form, MECS can be used to implement secure on-line discussions, shared workspaces, and collaborative generation of command sequences. There are also potential commercial applications for suitably modified versions of MECS: Many organizations need an efficient means of secure synchronization of remote systems. Inasmuch as nearly every software system developed previously to satisfy this need requires that the client initiate a request for specified data, there is no guarantee that a client has received the latest update to the shared data; in contrast, MECS, keeps client data files up to date.

This work was done by Paul Backes and Jeffrey Norris of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Information Sciences category.*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

Intellectual Property group
JPL
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Refer to NPO-20844, volume and number of this NASA Tech Briefs *issue, and the page number.*

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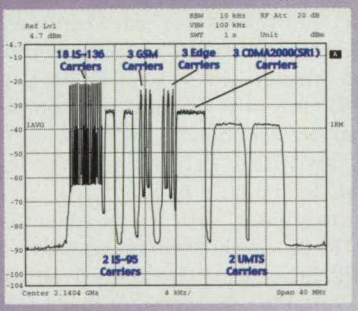


30 MHz Bandwidth

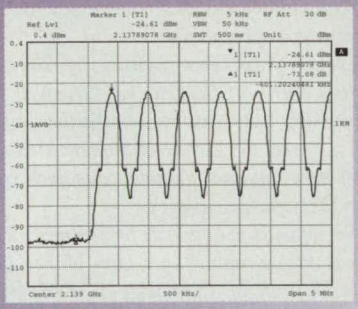
2.14 GHz Band
700 to 2200 MHz Range

>512 Msamples of Data Storage for Over 3 Seconds of Simulation

>70 dB Dynamic Range

Direct to IF Vector Signal Generation

GSM Standard



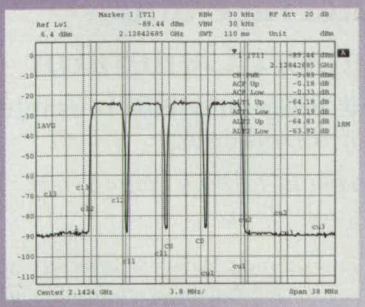
8 GSM Carriers
600 kHz Offset
2.14 GHz Band

–73 dBc IMD

+15 dBm PEP

Direct to IF Vector Signal Generation

UMTS (3.84 MS/s) Standard



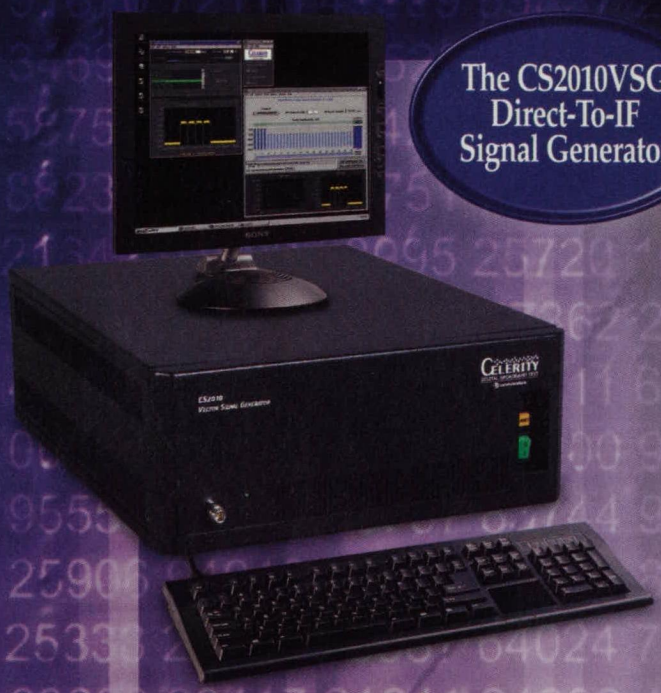
4 UMTS Carriers
Adjacent Channels
2.14 GHz Band

–64 dBc ACPR (eq BWs)

+19 dBm PEP

11.4 dB Crest Factor

Direct to IF Vector Signal Generation



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L3 communications

Software for Real-Time Transfer of GPS Data Over the Open Internet

NASA's Jet Propulsion Laboratory, Pasadena, California

Real-Time Net Transfer (RTNT) software allows for efficient and reliable transport of raw, GPS (Global Positioning System) observables over the open Internet. Efficiency is achieved by editing and compressing the GPS observables at the remote site, and by using User Datagram Protocol (UDP) rather than the higher overhead required of Transmission Control Protocol (TCP). However, TCP reliability is still achieved by the central server (the central collection computer) by monitoring sequence numbers of the remote client's packets. If there is a skip in sequence numbers, the central server may request retransmission of missed data packets from the remote clients. In this way over 98 percent of the data is returned to the central server. Once the central server receives the data, it may additionally retransmit the packets to other servers on the open Internet. This provides the capability of merging regional servers into a global server. There is a particular secondary server also running receiving data packets from the primary global server. If the secondary server no longer sees incoming packets, it will reroute the entire global network to itself. This provides a backup system should the primary server fail.

RTNT returns data from geodetic-quality receivers, such as Ashtech Z-12s, Turbo-Rogues, and AOA Benchmark receivers. Module construction of the s/w processes permits addition of other receivers. Five of six basic GPS observables are compressed down to 14.5 bytes per 1 Hz epoch, per GPS s/c tracked. The two phase observables (L1,L2) have a resolution of 0.02 mm, and the three range observables (CA,P1,P2) have a resolution of 1 mm.

RTNT is currently returning data with a latency of less than two seconds from a global network of 17 receivers. Latency here is defined as the time tag of the GPS observable and the time that the packet arrives at the central server. The Web page, *http://gipsy.jpl.nasa.gov/igdg/demo/index.html* contains the real-time operating status of the RTNT's global network. Data latencies and the number of GPS spacecraft tracked per remote site for the previous hour can be monitored through this Web page.

Once the data arrives at the central server, it is sorted by epoch, duplicate packets are rejected, request for retransmission of missed data packets are made, and the data is placed into a revolving segment of shared memory. From there, JPL's Real-Time Gipsy (RTG) software is used to compute global differential corrections to the GPS broadcast orbits and broadcast clocks. Real-time user position accuracy from this global differential system is 8 cm (RMS) in horizontal, and 20 cm (RMS) in vertical. The above Web page also contains a live demo of the receiver at JPL demonstrating these accuracies.

RTNT also provides the mechanism to distribute both the GPS broadcast orbits and clocks, and RTG's global differential corrections to the broadcast orbits and clocks over the open Internet. A server will fork dedicated TCP processes to any client making requests.

This program was written by Ronald Muellerschoen of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Software category.*

This software is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-20976.

Common Database Interface and Report Generator

This program yields reusable, centralized code.

Lyndon B. Johnson Space Center, Houston, Texas

The Common Database Interface and Report Generator is a computer program that serves as both (1) a single common interface for data-base application programs to gain access to local or remote data bases by use of Structured Query Language (SQL) operators and (2) a report generator.

The data-base-interface portion of the program enables a calling program to

gain access to an Oracle data base by use of all of the basic SQL operators (SELECT, INSERT, UPDATE, DELETE, COMMIT, and ROLLBACK). The program provides capabilities for logging in, logging out, and reporting errors. Each data-base function corresponds to a function callable in the C computing language. The calling data-base function passes the SQL statement as an argument to the called function.

For the SELECT function, the calling function also passes the function-specific callback routine as an argument. The callback routine is executed after each record has been retrieved from the data base. This unique approach allows the SELECT function without buffering of all the retrieved data. Status information is returned in the function return value.

The report-generator part of the program produces a plain text report, based on the contents of a report template. Instead of writing individual functions for each report, the user need only write templates to direct the report generator to generate the report. Any changes in the format of a report can be made by modifying the report template; there is no need to modify any computer code.

The report-generator part of the program invokes a report-template-parser subprogram to read in the report template via a report-template scanner. Then the report-generator part of the program passes, to a reporting-engine subprogram, the report structure and the arguments passed in from the calling program. The reporting engine generates the report output, invoking a data-base-access module to obtain data for the report and invoking a page-construction module to format the output.

The program affords full-featured error reporting capabilities. Multiple tables can be updated from the computer display screen; this feature saves a significant number of hours. Report templates can easily be changed without stopping the program; this feature helps to reduce cost.

The primary benefits afforded by this program are that (1) it yields reusable computer code, thereby reducing the cost of developing and maintaining code, reducing the number of lines of code that must be maintained, and (2) it centralizes the code, thereby making it easy to maintain. Because there is no need for a programmer to write Pro*C code, the level of required programming skill is correspondingly reduced.

This work was done by Fran Y. Mi of United Space Alliance and Kevin N. Shaum of Unisys for **Johnson Space Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Information Sciences category.*
MSC-22819

System Processes Data From Wind-Tunnel Acoustic Measurements

This system is a powerful aid for aircraft-noise-reduction research.

Ames Research Center, Moffett Field, California

A processing system has been developed to meet increasing demands for detailed noise measurement of aircraft in wind tunnels. Phased arrays enable spatial and amplitude measurements of acoustic sources, including low signal-to-noise sources not measurable by conventional techniques. The Microphone Array Phased Processing System (MAPPS) provides processing and visualization of acoustic array measurements made in wind tunnels. The system uses networked parallel computers to provide noise maps at selected frequencies in a near real-time testing environment. The system has been successfully used in two subsonic, hard-walled wind tunnels, the NASA Ames 7- by 10-Foot Wind Tunnel and the NASA Ames 12-Foot Wind Tunnel. Low-level airframe noise that cannot be measured with traditional techniques was measured in both tests.

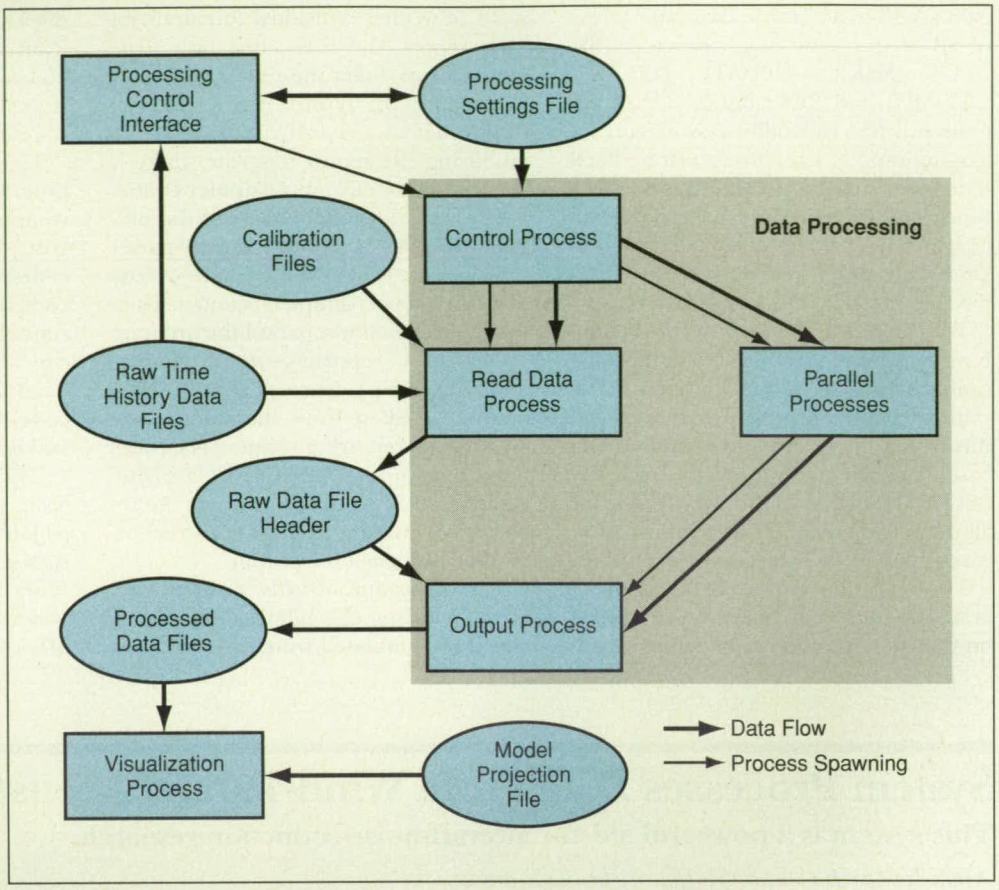
The MAPPS system is an end-to-end system designed to be used by researchers. MAPPS begins at the end of the data acquisition and storage and ends with the processed data visualization. This system is designed to be versatile and robust in its treatment of variable numbers of microphones, number and locations of processors, versatile calibrations, and visualization requirements. This versatility is designed into the system to provide for alternatives if components fail. These component failures will result in degraded results, but the results will still provide the researcher with information to meet their needs. MAPPS provides ease of use for processing and visualization with its system approach and graphical user interface (GUI). The system is designed so that the user may concentrate on research, testing, and data interpretation, instead of data and file manipulation.

An operational design goal for MAPPS was to provide sufficient results in near-real-time to allow the test director and researcher to make future run content decisions. The first operational test of MAPPS was in a recent Flap Edge test using a 100-element microphone array in the NASA Ames 7- by 10-Foot Wind Tunnel. The system had a 9-minute cycle from end of data acquisition to showing results on screen for 166 frequencies with 400 averages and a frequency resolution of 150 Hz. This cycle time was sufficient to obtain results from a small number of points for each run condition and to allow the test director to make model change and run condition decisions for the next run. Another operational design consideration was to have all the data processed and ready for examination by the next day. The ability to batch process multiple data points was also demonstrated at this test.

The MAPPS system (see figure) starts with a raw time history and produces a processed data file and computer visualization of the results. The input raw data file and the output processed data file are both stored in a widely-used self-describing, machine-independent binary file format called Network Common Data Format. Besides the basic data, these data files contain all the information related to the instrumentation, test setup, and test conditions. MAPPS includes many files and computer programs. The user sets all the processing parameters and initiates interactive processing through the Processing Control interface. The Processing Control interface reads the header information in the Raw Time History Data File. Processing parameters may be used from a file or set interactively based upon information derived from the header and displayed in the Interface. All the processing parameters are saved in the Process Settings File. The data processing occurs in four processes that run without user interaction once the Processing Control Interface or a UNIX script for batch processing starts the Control Process. The computer running the Control Process must have access to the Processing Settings File that was written by the Processing Control Interface. The Read Data Process must have access to the

Calibration File(s) and the Raw Time History Data File. When processing is complete, the Output Process writes the results and header to the Processed Data File. The header of the Processed Data File contains all the information from the header of the Raw Time History Data File plus all of the parameters used to process the data. Data visualizing is done in a separate process. Visualization requires access to the Processed Data File and Model Projection File.

Efficient and versatile visualization of array results is an essential part of MAPPS. MVIEW is a data visualization program written at Ames Research Center to view data processed with MAPPS. Scan results can also be loaded into the DARWIN system. This system allows searching of the database for desired test conditions and performing preliminary looks at the array results. Researchers can then use MVIEW to investigate the desired test conditions in more detail.



An Overview of MAPPS shows key processing activities.

Several types of data can be viewed in MVIEW. An overview plot contains three curves displaying the average level of all the good microphones, the maximum level found in the scan and the average level found in the scan as functions of frequency. This plot of curves assists the user in determining which frequency data to view in detail. Other plot windows display the scan maps of noise sources and model in two- and three-dimensional views. The scanned sources are displayed as colored maps and/or contours. The user can control the scale on the map. The scan maps can also be animated to display results for successive frequencies to run like a movie by clicking on the start animation button in the overview plot window.

This work was done by Michael E. Watts and Marianne Mosher of **Ames Research Center** *and Jorge Bardina and Michael Barnes of Caelum Research Corp. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Systems category.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Ames Research Center, (650) 604-5104. Refer to ARC-14258.

Software for Displaying Coregistered Sets of Data

NASA's Jet Propulsion Laboratory, Pasadena, California

The DataSlate computer program is being developed to help educators and students gain access to, view, manipulate, and otherwise interact with sets of planetary and other scientific data via the Internet or via local data-storage facilities. DataSlate will be especially useful for displaying coregistered sets of data; for example, a topographical map of a region and a photograph of the same region taken from an aircraft or a satellite. DataSlate, associated software tools, and sets of data will be distributed via the Internet or provided on compact-disk read-only memories (CD-ROMs). The architecture of DataSlate is extensible, so that new software tools and sets of data can be added and educators can design new components of curricula. Sets of data, lesson plans, and software tools can be created by educators and students and uploaded to servers for public use or kept on local computers for private use. The initial development of DataSlate has been a joint project of NASA's Jet Propulsion Laboratory, the University of Nebraska at Lincoln, and Johns Hopkins University. Both DataSlate and a set of software tools for preparing associated sets of data and curricula are expected to be extended by a team of developers within the next few years. DataSlate will be useful to the scientific community and the general public as well as to the educational community.

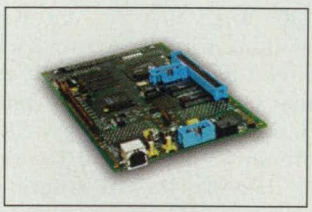
This program was written by David S. Hecox of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Software category.*

This software is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-19911.

Dewetron, Charlestown, RI, has introduced the DTRS-1™ **telemetry recording system**, a 19" rack-mounting unit that features an open architecture. The system combines data recording, display, live video input, and voice/sound recording in one computer-based platform. Built-in high-speed Ethernet allows multiple systems to be interconnected for data exchange, printer sharing, and access to common setups and databases.

Data is monitored on a flat panel TFT display, which includes its own video input tuner and speakers. Live video feeds showing test data can be displayed picture-in-picture or full-screen. The computer platform allows one or more A/D boards to be installed. The system can be equipped with IRIG/GPS time-code interface cards. The system front end is provided by plug-in signal conditioning modules. The base system has 16 dynamic inputs, with 12- or 16-bit resolution, and sample rates to 1.25 MHz.

For More Information Circle No. 726



Innovative Integration, Simi Valley, CA, offers the SBC6711 **data acquisition and control board**, a standalone I/O board for embedded, control, and signal processing applications requiring data acquisition coupled with on-board processing. The board features dual plug-in sites for interchangeable, modular I/O, and is equipped with Texas Instruments' floating-point digital signal processor.

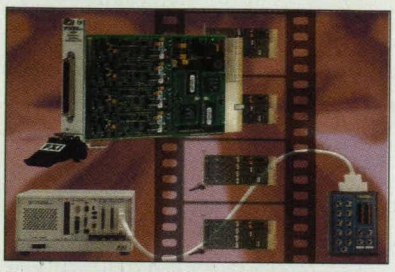
Onboard peripherals include 512 KB of cache-controlled synchronous code/data RAM, 1 MB of reprogrammable FLASH memory for code and data storage, 12 MB/sec USB interface, and two multi-channel buffered serial ports. Also included are two general-purpose timers, a host-port interface, and an external memory interface capable of interfacing to SDRAM, SBSRAM, and asynchronous peripherals.

For More Information Circle No. 725

Pacific Instruments, Concord, CA, offers the 6005 Mainframe, a battery-operated **data acquisition system** for portable applications. It features space for 72 channels, and can be expanded to more than 2,000 channels by adding slave enclosures. The system is used with the company's PI660 acquisition and display software, and a laptop computer. The system has all connections and controls on one surface for placement in tight locations.

The HS-GPIB interface, used for programming, control, and recording of data, provides data rates up to one million samples per second. The unit is configured for specific transducers by plug-in signal conditioning modules. Input types range from 2-wire voltage to 8-wire full bridge, and include digital inputs and outputs, as well as rotational and time measurements. Capabilities include voltage and current excitation, remote sensing, voltage and shunt calibration, 100 kHz bandwidth, and simultaneous sampling.

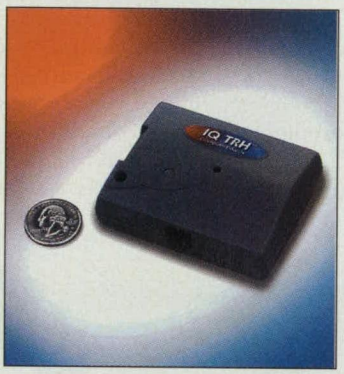
For More Information Circle No. 730



The 6115 simultaneous sampling **data acquisition device** for PXI/Compact PCI is available from National Instruments, Austin, TX. The 12-bit multifunction I/O device samples measurements up to 10 MS/s on each of four channels. Users can record high bandwidth signals, including those from mobile telephony, radar, sonar, and ultrasonic systems, as well as analyze high-frequency characteristics or transients within analog or digital waveforms.

Features include input bandwidth of 5 MHz, analog and digital triggering, eight digital I/O lines, four differential 12-bit analog input channels, and two analog output channels. It also includes 64 MB of onboard SDRAM capable of storing 32 million samples. The system comes with NI-DAQ driver software, and has two 24-bit, 20-MHz counter/timers.

For More Information Circle No. 728



The IQ-TRH and IQ-TRH-40 **data loggers** from Measurement Computing, Middleboro, MA, are designed for remote, battery-operated monitoring of relative humidity and ambient temperature. Readings are saved to an internal nonvolatile memory. The IQ-TRH holds up to 31,920 samples; the IQ-TRH-40 holds up to 64,680 when logging a single relative humidity channel.

The loggers have three start modes: pushbutton, user-programmed delay, and point capture start. The front-panel LED confirms start status initiation. When a recording session is complete, users reconnect the loggers to a PC and download data directly to a Microsoft Excel worksheet. An available PC interface kit includes a serial cable and IQ-Wizard software for set-up and download of data.

For More Information Circle No. 727

Validyne Engineering Corp., Northridge, CA, has introduced the VDAS™ 200/800/1500 **portable data acquisition system** that records up to 300 channels of sensor inputs with 1000V isolation and cold reference junctions on all channels. The system is suitable for a range of applications such as testing in automobiles, aircraft, and other vehicles. The unit is available in three chassis sizes for use with two, eight, or 15 modules, with 10 to 20 data channels per module.

The rugged steel package measures 8 × 10 × 17", features swivel handles, and weighs 30 pounds when configured with 15 modules. Mounting holes allow the case to be secured to the vehicle, or to secure other instruments to the system. Users can select from four different interchangeable modules: voltage/temperature, strain gage, frequency, and CAN vehicle bus interface. The system comes with either a National Instruments LabVIEW™ interface, or Validyne's proprietary Windows-based PC software.

For More Information Circle No. 729

The Wireless Augmented Reality Prototype Concept

Head- and belt-mounted units would enable wearers to communicate data.

NASA's Jet Propulsion Laboratory, Pasadena, California

The Wireless Augmented Reality Prototype (WARP) is a system for personal access to a local area network with video, audio, and sensor data services. The center of the WARP system is a lightweight, unobtrusive heads-up display with a wireless wearable control unit, called the Remote Access Unit (RAU). Data services to the RAU are provided through a high-rate radio link from the WARP RAU to a stationary base-station interface unit which sits on an ordinary local area network. The RAU-to-interface unit radio link has been engineered to operate within the high-interference, high-multipath environment of a space shuttle or space station module.

The key to WARP is the streamlining and miniaturization of the wearable RAU, allowing long-term use without battery replacement or continuous re-loading of new data. This has been accomplished by paring the RAU electronics down to include only highly integrated video and audio compression/decompression and data multiplexing circuits along with a high-rate two-way radio link. This approach not only allows real-time video and audio conferencing through WARP, but also removes the requirement for information to be stored in the wearable unit. Instead, the most up-to-date and directly relevant data may be retrieved on demand, as real-time situations dictate.

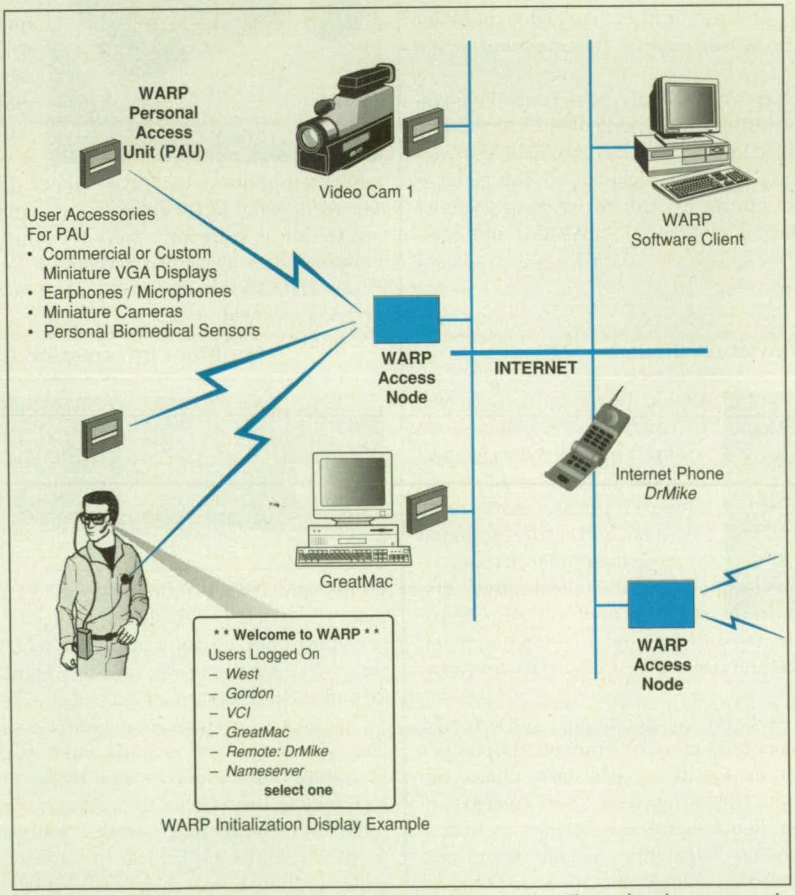
One of the major technology challenges with this concept has been to provide wireless high-rate information in the environment of a space module. Tight confines, metal walls, and lack of radio absorbers create an enormous potential for destructive self-interference. The development of this radio technology is synergistic with the development of technology for efficient and high-quality video data compression; the WARP communications channel contains video, audio, and sensor data simultaneously.

In the space station applications, a virtual terminal is provided by a RAU and headset pair. The user will be able to view and manipulate imagery, text or video, using voice commands to control the terminal operations. WARP hands-free access to computer-based instruction texts, diagrams, and checklists replaces juggling manuals and clipboards, and tetherless computer system access allows free motion throughout a cabin while monitoring and operating equipment.

Along with information provided to the astronaut, WARP also allows external observation of the astronaut's situation; personal biosensors connected to the RAU can send back continuous telemetry and a miniature camera integrated into the headset provides real-time video of the wearer's field of view. In this way, for example, a principal investigator located on Earth may consult with a payload specialist on the operation or troubleshooting of the equipment. Using this same mechanism, WARP RAUs may also be used with stand-alone wireless sensor packages that send data, from low-rate environmental sensors or high-rate cameras, back through the existing WARP wireless network to the base station. Packetized data may be sent to various monitor computers for logging or alarm.

Future applications of WARP are in any environment where heads-up, hands-free information retrieval — and remote situational awareness — improves efficiency, including field operations, tetherless operations/monitor consoles, remote consultations in medical or maintenance procedures, and hazardous or confined-space activities. The extension of WARP system and RAUs into a wireless SensorNet is a novel approach to space or air vehicle infrastructures, saving mass and providing flexibility over hard-wired sensor or camera installations.

The WARP program has built and integrated several Phase II WARP systems. The Phase II system supports single, independent RAU-to-base station connections to a



The **Wearer Would Interact With a Computer** in a base station. Through voice commands, the wearer would control some functions of the computer. The head-mounted display terminal would serve as a remote display device of the computer.

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single PC. Phase II WARP is under evaluation at Johnson Space Center. Development is now underway on Phase III WARP, which will allow each interface unit to network multiple RAUs, and will allow individual RAUs to be supported dynamically by multiple interface units which are installed in a cellular network type model throughout an extended area.

This work was done by Martin Agan, Ann S. Devereaux, and Thomas Jedrey of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Systems category.*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

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Refer to NPO-20621, volume and number of this NASA Tech Briefs *issue, and the page number.*

MQW Based Blocked Intersubband Detector for Low-Background Operation

The basic design is modified to suppress space-charge buildup and its deleterious effects.

NASA's Jet Propulsion Laboratory, Pasadena, California

Multiple-quantum-well (MQW) $Al_xGa_{1-x}As/GaAs$ infrared photodetectors that are better suited [relative to prior $Al_xGa_{1-x}As/GaAs$ quantum-well infrared photodetectors (QWIPs)] for operation under low-background conditions are undergoing development. These devices are expected to function at a temperature of 30 K without nonlinear effects or delayed responses. Even at this low temperature, the readout electronic circuits for imaging arrays of these photodetectors are expected to work smoothly — that is, with no freeze-out of charge carriers. Large focal-plane arrays of these detectors should be relatively inexpensive because they could be fabricated by use of mature techniques for the growth and processing of $Al_xGa_{1-x}As/GaAs$.

Some background information is prerequisite to a meaningful description of the present MQW photodetectors: The operation of QWIPs is based on photoexcitation of electrons between ground and first-excited-state subbands of quantum wells, which are formed by stacking alternate layers of two different, high-bandgap semiconductor materials (e.g., $Al_xGa_{1-x}As$ and GaAs). The discon-

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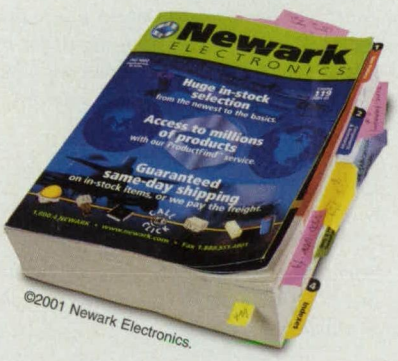

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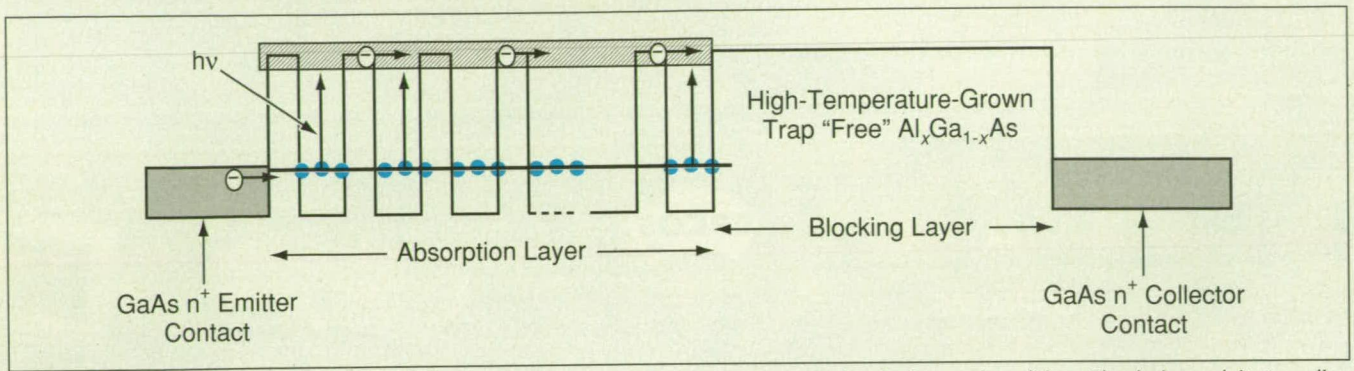

This is an **Energy-Level Diagram** of an MQW device designed for improved performance under low-background conditions. The device exploits tunneling between the negative n+ GaAs contact layer and the wells in the MQW emitter section for ultra fast replenishment of depleted wells, while the thick undoped $Al_xGa_{1-x}As$ barrier layer suppresses undesired tunneling between the MQW emitter section and the positive n+ GaAs contact layer. (Note: h=Planck constant; ν = frequency of radiation.)

tinuity in bandgaps between the two materials gives rise to quantized subbands in the potential wells associated with conduction bands. The parameters of the layers are chosen so that photoexcited charge carriers can escape from the potential wells and be collected as photocurrent. Thus, in principle, a QWIP operates similarly to an extrinsic bulk photoconductor.

Electrons in the subbands of the isolated quantum wells in a typical prior QWIP can be visualized as electrons attached to impurity states in bulk photoconductors. As a photogenerated electron leaves the active doped quantum-well region, it leaves behind a hole that constitutes an increment of space charge. For operation under low-background conditions, QWIPs are designed to have extremely low tunneling currents and extremely low thermionically emitted dark currents at low temperature (30 K). Hence, in the event of low background irradiance, the high resistivity of the active region (a consequence of the large thickness of the barriers between wells) can lead to a delay in refilling the wells. This delay, in turn, results in a decrease in responsivity with an increase in the frequency of intensity modulation of the infrared radiation that one seeks to detect. This frequency response is similar to that associated with dielectric relaxation in bulk photoconductors. This completes the background information.

The developmental MQW based Block Intersubband Detectors (BID) are designed to suppress the deleterious effects described above. A device of this type (see figure) includes a heavily doped MQW emitter section with barriers that are thinner than in prior QWIP devices. The thinning of the barriers results in a large overlap of sublevel wave functions, thereby creating a miniband. Because of sequential resonant quantum-mechanical tunneling of electrons from the negative ohmic contact to and between wells, any space charge is quickly neutralized. At the same time, large tunneling current through the whole device is suppressed by a relatively thick, undoped $Al_xGa_{1-x}As$ layer between the MQW emitter section and the positive ohmic contact. [This layer is similar to the thick, undoped silicon layers used in the block impurity band (BIB) type.]

This work was done by Sarath Gunapala, Sumith Bandara, John K. Liu, Sir B. Rafol, David Ting, and Jason Mumolo of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Systems category.*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

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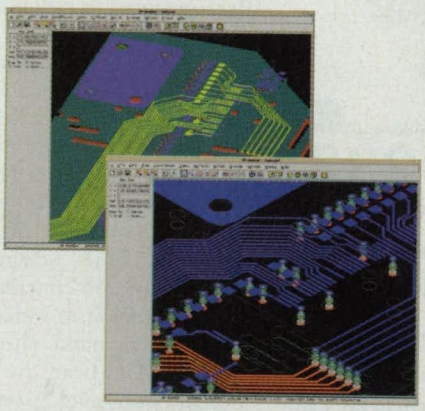

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Airfield Wind Advisory Systems for General Aviation

These systems reduce risks associated with unknown winds during takeoffs and landings.

Dryden Flight Research Center, Edwards, California

An Airfield Wind Advisory System (AWAS) includes a self-contained weather station, located at an airfield, that measures speed and direction of the wind, the temperature, the barometric pressure, and the humidity. This ground station digitizes these measurements and transmits the measurement data in real time, via radio, to portable units in aircraft cockpits. The portable units automatically detect the data and display the information to pilots. In 1999, a prototype of the AWAS system was demonstrated to function successfully in tests at Kennedy Space Center's Space Shuttle Landing Facility in 1999.

An AWAS ground station is designed for automatic operation with minimal maintenance, using either alternating current from a power line or power from a solar photovoltaic array with battery backup. AWAS ground stations can include solid-state transducers with no sliding parts (e.g., sonic anemometers and/or strain-gauge wind sensors) for high reliability but could also be designed to take advantage of previously installed anemometers, weather vanes, and other weather-measurement devices. AWAS ground stations can also contain Web server computers, which transmit the information to wide-area networks over intranet or Internet links upon demand. The transmitted information can include not only the data from the AWAS weather measurements but also Global Positioning System (GPS) data and/or other geophysical data from measurement devices to support scientific observations.

An AWAS airborne unit includes an antenna, receiver, microprocessor, data-storage elements, a power supply, and a back-lit liquid-crystal display device. The simplest version provides a no-clutter display that can be read by the pilot in a one-second glance, showing the following data:

- The identity of the airfield [represented by a three- or four-character label assigned by the Federal Aviation Administration (FAA) to every airfield or helipad],
- The direction of the wind in degrees measured from magnetic north,
- The steady-state and peak gust wind speeds in knots, and
- The most favorable runway for takeoff and landing.

In order to select the most favorable runway, the microprocessor in the airborne unit compares the wind vector with the runway heading (runway headings are stored in an internal database) and calculates the headwind and crosswind values. The runway indicated on the display device is the one with the highest headwind and lowest crosswind components. A switch enables the pilot to command the display of the headwind and crosswind data for the selected runway.

A standby switch shuts off the display device, but allows the remainder of the airborne unit to operate in a listening mode to conserve energy when not in range of an airfield. Advanced versions may include keypads to enable pilots to select specific airfields or runways or to enter special data or queries.

Specialized AWAS software, which may also be incorporated into wireless personal data assistants (PDAs) and hand-held GPS devices, could provide graphical depictions of airfield diagrams and winds. The Internet version of the AWAS is intended for use with wireless PDAs and cellular telephones that provide access to the Internet.

The AWAS can also be used to disseminate weather information in real time in applications other than aviation. Examples of

potential users include the National Weather Service, the military, commercial weather services, marine and agricultural concerns, the Federal Emergency Management Agency, and emergency services (e.g., firefighters during forest fires).

The receiver in an AWAS airborne unit automatically detects the signal from an AWAS ground unit at an airfield and activates the display device when in range of the airfield. The display helps the pilot to select the optimum approach to the airfield while 8 to 10 miles (about 13 to 16 km) out, thus saving three to five minutes per landing. Under visual flight rules (VFR), approaching an uncontrolled field, the pilot is required to make contact with the UNICOM of the airfield to request wind and runway information (UNICOMs are non-government communication facilities that provide airport information at some airports). If there is no answer, as is often the case, the pilot must fly over the airfield to view the windsock while visually avoiding other traffic, estimating the wind speed, and entering the traffic pattern to land, trusting that other pilots are also making the same assumptions about the winds and the landing runway. This procedure typically involves extra maneuvering and backtracking. With the AWAS, the pilot knows the wind at the airfield and knows which runway is most favorable, and is therefore able to fly a more direct approach to the landing pattern, without guesswork or extra maneuvering. More importantly, the pilot knows the headwind and crosswind for each runway without question, and will therefore be able to plan ahead for the appropriate aircraft alignment and control inputs.

According to the Aircraft Owner's and Pilots Association annual aviation safety report for the U.S. (the Nall Report), takeoff and landing accidents are "seldom fatal", but the numbers of such accidents are still considerable. During the year of the 1998 report, there were 743 takeoff and landing accidents, which resulted in 46 fatalities. One can infer that the number worldwide is at least 100 per year. The AWAS can contribute significantly to a reduction in the numbers of such mishaps and fatalities. As shown in the Nall Report for general aviation, the greatest number of accidents by far occurs during the takeoff and landing phases of flight. These two phases require the greatest skill and most intense concentration from the pilot, and occur when the aircraft is closest to the ground, at its most vulnerable maneuvering speed, and with the least amount of maneuvering airspace. Wind conditions are extremely critical during these phases of flight. By having the current wind and gust conditions immediately available, the pilot can mentally prepare the approach or takeoff in advance, and reduce the need for surprise reactions. The AWAS can also reduce the risks associated with practicing crosswind landings by making the wind information always readily available to the student pilot and instructor.

This work was done by Gerald E. Brown and Paul A. Curto of NASA Headquarters and Jan A. Zysko of Kennedy Space Center for **Dryden Flight Research Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Systems category.*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Dryden Flight Research Center; (805) 258-3720. Refer to DRC-99-16.

Computing Radiation Fluxes, Power, and Temperature for TOPEX

A computer program performs a unified analysis of the radiation exposure, the temperatures, and the power generation and distribution for predicting the performance of the TOPEX satellite on orbit and during maneuvers. The unified analysis is needed because all aspects are interdependent. The power-generating capacity of the solar array of the satellite depends on both the impinging radiation fluxes and the temperatures of the panels. The temperatures, in turn, depend on the power output of the array in addition to the radiation fluxes. Only by considering electric-power generation and consumption, radiation fluxes, and temperatures together can one predict any one of them as well as the state of charge, the voltage, and the current of the batteries. The present computer program predicts the power profile and the solar, albedo, and infrared fluxes on all surfaces of the satellite. It calculates the temperatures of the solar array and its power-generating capacity as function of radiation exposure and temperature. Battery currents and voltages are determined on the basis of the calculated state of charge of the batteries and the power-generating capacity of the solar array as a function of its radiation exposure and its temperatures. All pertinent values are stored in files with any desired time interval.

This program was written by Robert Richter of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Software category.*

This software is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-21018.

Program for Updating Parameters of Thermal Models

Parameter Identification in Thermal Networks (PITN) is a computer program developed to satisfy a need to update parameters in mathematical models of thermal systems in order to make the temperatures computed by the models equal to the temperatures measured in tests of the corresponding real systems. PITN is suitable for application to network-type models of scientific instruments and general engineering systems, including telescopes, spectrometers, and spacecraft. Relative to software developed previously for the same purpose, PITN can readily be applied to more complex models and yields results in less time. In addition, PITN can accommodate nonlinearities in thermal models (nonlinearities are typically associated with radiative heat transfer). PITN is based partly on the formulation of the parameter-matching problem as a nonlinear least-squares optimization problem, which can be solved by use of very fast and robust optimization techniques. The speed and accuracy of computations are increased by use of analytic expressions for temperature differentials.

This program was written by Miltiadis Papalexandris and Mark Milman of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Software category.*

This software is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-21067.

Program Tracks Operation of a Remote Solid-State Recorder

Solid State Recorder Pointer Tracker (SSRPT) is a computer program developed specifically to aid ground-based monitoring and control of two redundant solid-state recorders (SSRs) aboard the Cassini Spacecraft. The SSRs store telemetry data until downlink times, which are limited to a total of about 8 hours per week. With respect to the SSRs, SSRPT serves as an inexpensive substitute for a complete hardware-and-software simulator of the spacecraft. SSRPT makes it possible to track recording- and playback-pointer address positions in the SSR, thereby making it possible to (1) minimize the use of precious uplink and downlink time by commanding the downlinking of only data of interest stored at known addresses and (2) inhibiting recording at addresses from which data are required but have not yet been played back. SSRPT functions in two modes: (1) a calculator mode, in which it performs basic computations where recording and playback bit rates are multiplied by time intervals; and (2) a sequence-predictor mode, in which it predicts pointer positions according to the time line of commands sent to the spacecraft.

This work was done by Edwin P. Kan, Shahen Petrosian, and Barbara Larson of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Software category.*

This software is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-20423.

Library for Developing Spacecraft-Mission-Planning Software

The Platform Independent Software Components for the Exploration of Space (PISCES) software library provides for web-based, collaborative development of computer programs for planning trajectories and other trajectory-related aspects of spacecraft-mission design. The PISCES library was built using state-of-the-art object-oriented concepts and software-development methodologies. The components of PISCES include Java-language application programs that implement trajectory-propagation algorithms, including gravity models, atmosphere models, planetary ephemerides, and orbital propagation. Extensive generalized rendezvous-planning software is also included. These components are arranged in a hierarchy of classes that facilitates the re-use of the components in planning trajectories. As its full name suggests, the first advantage of the PISCES library is platform-independence: By using the "write once, run anywhere" capability of Java, anyone can use the classes and application programs with a Java virtual machine, which is available in most web-browser programs. The second advantage of the library is expandability: Object orientation facilitates the expansion of the library through the simple creation of a new class.

This work was done by Don Pearson and Dustin Hamm of **Johnson Space Center**, *with support from Jonathan K. Weaver of JSC and Brad Holcomb and Brian Kubena of Lockheed Martin. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Software category.*

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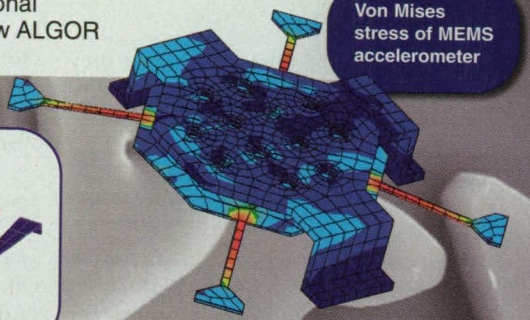
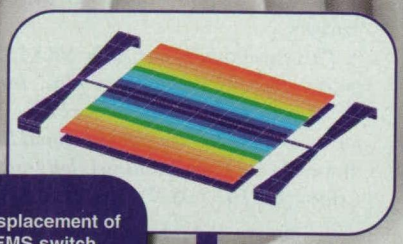


Von Mises stress of MEMS accelerometer

Electric field of MEMS radial comb motor



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- An easy-to-use graphical user interface that enables engineers to directly apply electrostatic forces to a structural model and provides right-click functionality for applying, modifying and removing loads, constraints and finite element properties
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- InCAD technology for CAD/CAE interoperability within Autodesk Inventor, CADKEY, Mechanical Desktop, Pro/ENGINEER for Windows, Solid Edge and SolidWorks
- Unstructured brick and tetrahedral meshing
- A midplane mesh engine that automatically converts thin solid parts into plate/shell elements
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Photos courtesy of Sandia National Laboratories

Lightweight, Collapsible Hyperbaric Chamber With Airlock

Hyperbaric treatment could be provided in settings remote from major medical facilities.

Lyndon B. Johnson Space Center, Houston, Texas

A lightweight, collapsible hyperbaric chamber/airlock system has been proposed as a portable unit for treating decompression sickness. Copies of the system could be stowed compactly and deployed when needed in settings in which decompression sickness is expected to occur occasionally but in which conventional heavy, rigid hyperbaric chambers are not available. Such settings include aviation, submarine operations, diving, and spaceflight.

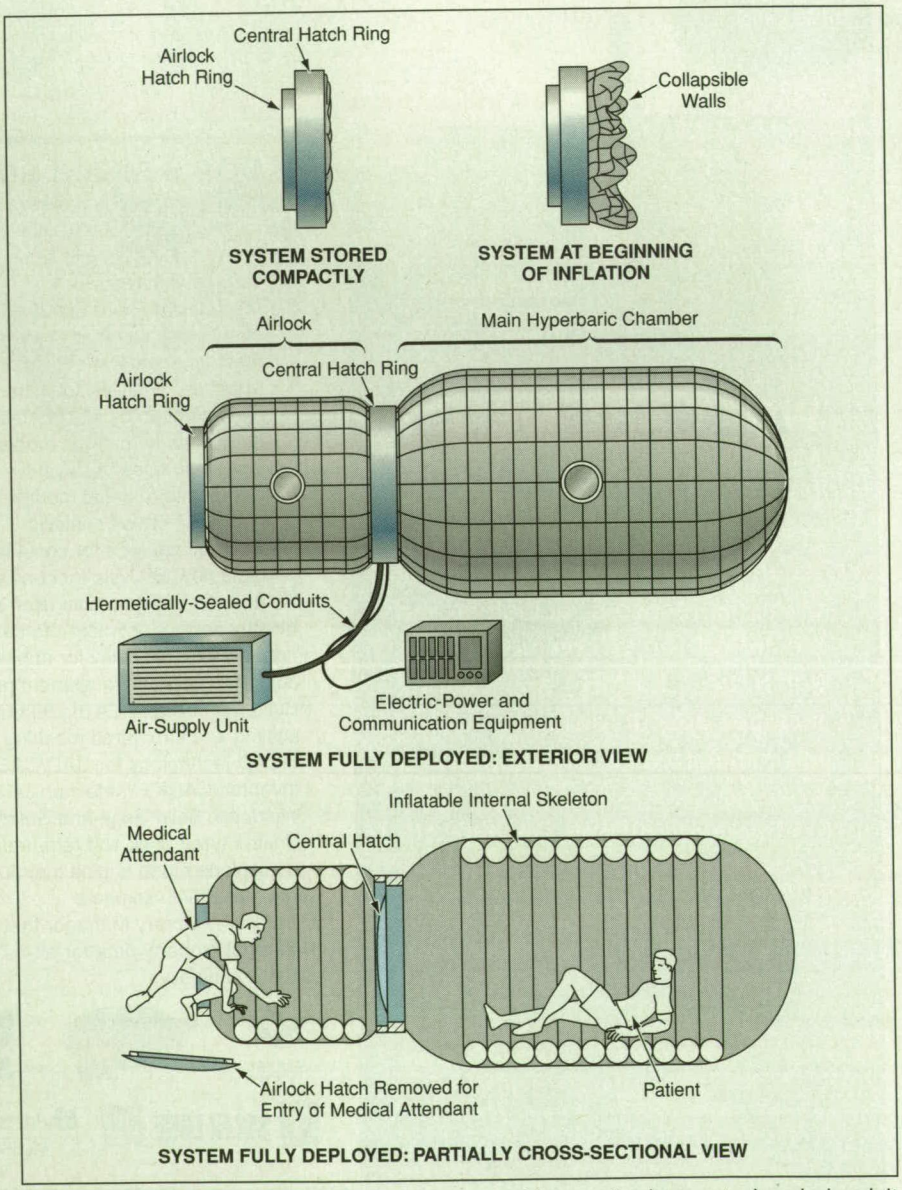
The system (see figure) would include a main hyperbaric chamber and an integral airlock, both capable of maintaining an interior pressure of 2 atm (0.2 MPa) for one patient and a medical attendant. One would gain access to the main hyperbaric chamber via the hatches at the ends of the airlock. The central hatch ring at the junction of the airlock and the main chamber would be penetrated by hermetically sealed conduits that would provide air, medical oxygen, electrical power, and communication from external equipment to both the airlock and the main chamber.

The walls of the main chamber and the airlock would be made of multiple layers of lightweight, flexible materials, and could be folded to a small volume. Included among the wall layers would be pressure bladders, plus flexible circumferential and longitudinal straps that would afford the strength to withstand pressurization. The airlock hatch ring would be sized to fit within the central hatch ring to minimize storage volume. An internal skeleton of interconnected low-pressure inflatable toroids (reminiscent of an inflatable raft) would maintain the main chamber and airlock in the expanded condition when the main chamber, the airlock, or both were not pressurized, thereby facilitating entry and egress. The inflatable toroids could also serve as a cushion for the patient during hyperbaric treatment.

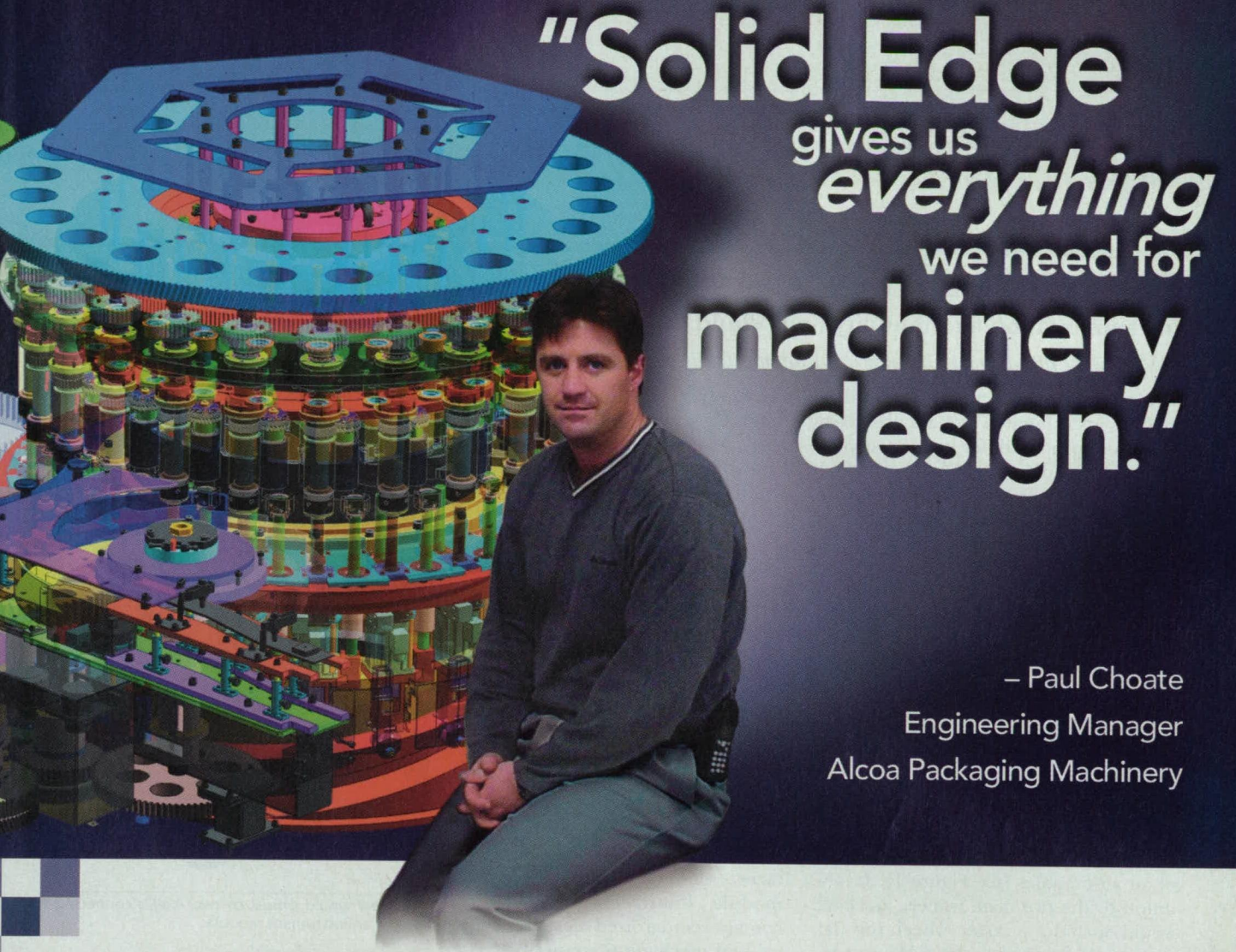
The central and airlock hatch rings would serve as seal lands for the central and airlock hatches. The hatches would include rings, to which would be attached strap and pressure-bladder layers like those of the chamber walls. The hatches would be elliptical so that they (rotated 90°) could fit through the elliptical hatch openings to facilitate access. The hatches would be held in place temporarily by magnets until pressurization seated them firmly and compressed the hatch seals.

This work was done by William C. Schneider, James P. Locke, and Horacio M. De La Fuente of **Johnson Space Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mechanics category.*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-0837. Refer to MSC-23076.



This **Hyperbaric Chamber/Airlock System** could be stored in a small volume, yet when deployed, it would accommodate a patient and a medical attendant.



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Reconfigurable Exploratory Robotic Vehicles

Instrumentation and mobility units could be concatenated as needed.

NASA's Jet Propulsion Laboratory, Pasadena, California

A family of rugged, modular, reconfigurable, instrumented robotic vehicles has been proposed for use in exploration of the surfaces of Mars and other remote planets. These or similar vehicles could also be useful in such diverse terrestrial applications as exploration of volcanic craters or other hostile terrain, military reconnaissance, inspection of hazardous sites, or searching for victims of earthquakes, landslides, or avalanches. There might even be a market for simplified versions of these vehicles as toys.

The proposed vehicles are denoted generally by the term *Axel*n, where n is an even number equal to the number of main wheels. The simplest vehicle of this type would be an *Axel*2 — a two-main-wheel module that would superficially resemble the rear axle plus rear wheels of an automobile (see Figure 1). In addition to the two main wheels, an *Axel*2 would include a caster wheel (or flat surfboard) attached to the axle by an actuated caster link. The motion (about three quarters of a circle) of the caster link would be used to control the rotation of the axle in order to tilt, to the desired angle, any sensors that might be mounted on the axle. The *Axel*2 would hence use the same sensors for forward and backward driving. In the vertical position, the caster link is used as an antenna for wireless communication. Two brushes attached to either side of the caster link wipe dust off the solar cells.

In addition to the sensors, the axle of an *Axel*2 would house computer modules and three motors and associated mechanisms for driving the main wheels and the caster link. Solar cells would be mounted on the outside of the axle except at a mid-length portion, where an assembly containing the caster-link actuator and two module interfaces (one at each end) would be located. Rechargeable batteries would be placed inside the wheel hubs.

One would construct an *Axel*n (n > 2) as an assembly of multiple *Axel*2's plus one or more instrument module(s) connected to each other at the module interfaces (see Figure 2). The module interfaces would contain standardized electrical and mechanical connections, including spring-loaded universal joints, about which the modules could comply to adapt to the terrain. Data would be communicated between modules via fast serial links.

An *Axel*n would amount to a train carrying n/2 – 1 instrument modules. The instrument modules would contain additional computational units that, in addition to processing of instrument readings, could contribute to coordination of train motion. In other words, the "intelligence" of an *Axel*n, and thus the sophistication of the maneuvers that it could perform, would increase with n.

The symmetrical design of the modules would enable them to operate in any stable orientation, including upside-down; this feature would contribute to robustness of operation in rough terrain, including the ability to recover after falling off a cliff (in the case of *Axel*n where n < 6). The simple and modular design of the *Axel*s provides better maneuverability using fewer actuators and sensors and hence lower power requirements than traditional rovers. The system features scalable complexity: the motion control algorithms for the *Axel*2 are very simple; and as the size of the *Axel* train grows, the complexity of the algorithms increases.

The proposed vehicles would be designed to diagnose themselves to detect nonfunctional modules. They would be programmed to travel to robotic service depots, called assembly stations, where nonfunctional modules would be disconnected and replaced by functional ones.

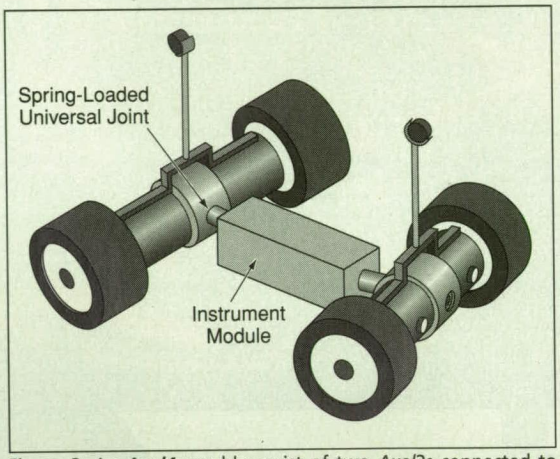


Figure 2. An ***Axel4*** would consist of two *Axel*2s connected to opposite ends of an instrument module.

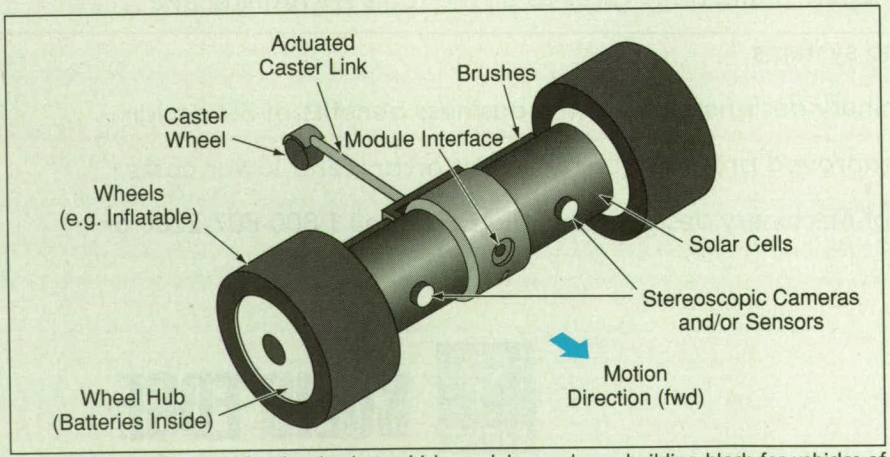
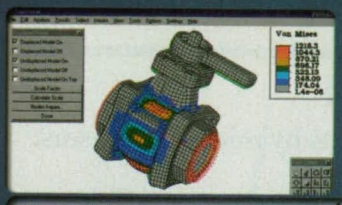


Figure 1. An ***Axel2*** would be the simplest vehicle module, used as a building block for vehicles of greater complexity.

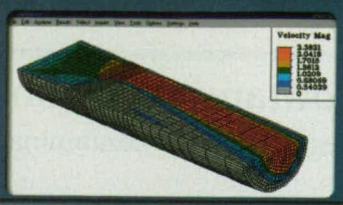
This work was done by Issa Nesnas of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Machinery/Automation category.*

NPO-20944

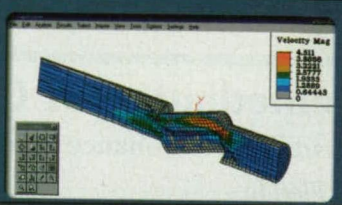
12 Reasons Why Algor Should Be Your FEA Partner



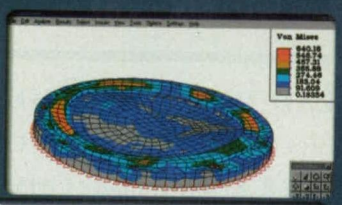
Linear Static Stress - Algor's linear static stress product enables you to capture complex assemblies, such as this valve assembly, from a CAD solid modeler and run a finite element analysis using fast solver technology. Typical loadings are pressure, acceleration, temperature, force and prescribed displacements.



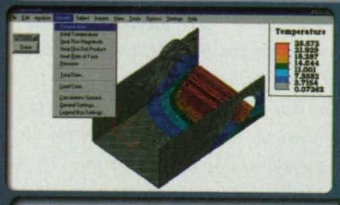
Steady Fluid Flow - Prescribed velocities and pressures provide the loading for this 3-D steady fluid flow analysis of a pipe with a gate valve. Algor's multiple load curves allow for easy data entry for adding loading such as gravity.



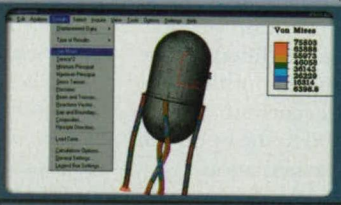
Unsteady Fluid Flow - Unsteady fluid flow of this ball valve system was analyzed using a 3-D CAD solid model. Algor's unique processor solves for velocities and pressures throughout the dynamic event, using a specialized meshing algorithm for high velocity gradients.



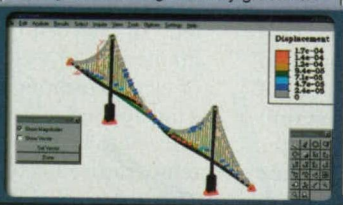
DDAM - Algor's Dynamic Design Analysis Method enables you to analyze the shock response at the mountings of shipboard equipment such as watertight doors, masts, propulsion shafts, rudders, exhaust uptakes and portholes, as shown above.



Transient Heat Transfer - The dynamic effects of a transient heat transfer analysis were needed for the time-dependent temperature loading of this heat sink assembly. Algor's multiple load curves for various loading conditions allow for the simulation of the thermal event.

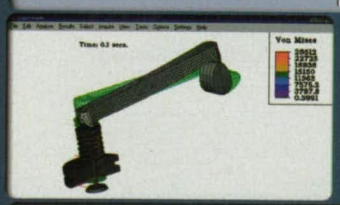


Nonlinear Static Stress - Algor's nonlinear product helps to accurately predict large deformation and large strains caused by static loading. As seen by this water tank, buckling of a structure is one type of failure that can be exposed.

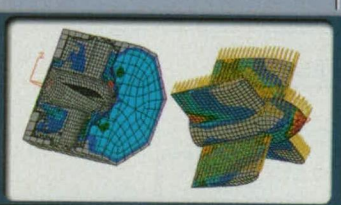


Linear Dynamic Stress- A modal analysis is one of the linear dynamic stress analyses performed on this suspension bridge. Failure can occur when the loading frequency is at the structure's resonant frequency. Algor's linear dynamic analyses accurately predict these frequencies and dynamic effects.

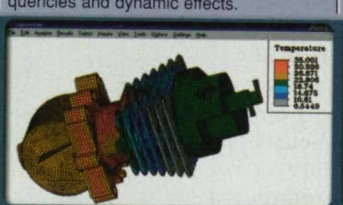
Mechanical Event Simulation (MES) with Nonlinear Material Models - Algor's MES extends full dynamic analysis capabilities to large strain/deformation analyses of nonlinear materials, as shown by this landing gear assembly. Kinematic elements can be used for quicker processing.



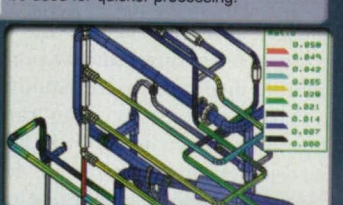
Mechanical Event Simulation (MES) with Linear Material Models - Algor's MES with linear material models allows you to represent a dynamic analysis while solving for kinematics, deflections and stresses of the structure. Analyses using large CAD assemblies, such as this rocker arm assembly model, can be expedited by using kinematic elements.



Multiphysics - Algor's multiphysics products enable you to combine multiple analysis types into one event. Resultant forces from flow around this turbine were calculated and then projected onto the object for a structural analysis. Other multiphysics capabilities include combining heat transfer with fluid flow, heat transfer with static/transient stress and heat transfer with fluid flow and stress.



Steady-State Heat Transfer - Algor's steady-state thermal processor helps predict temperature distribution due to thermal loading. Loading such as convection, radiation, conduction, applied temperatures and surface heat fluxes can be added to an analysis for fast, accurate results. In the case of this engine casing, both conduction and convection were part of the analysis of this 3-D solid model.



Piping Design and Analysis - Algor's piping design and analysis product enables you to calculate the deflections and stresses of this plant piping system and then compare the results with ASME/ANSI code allowables. Loadings can include: dead weight, thermal differences, pressure, wind loads, earthquake loads, time history of forces/displacements, response spectrum, natural frequencies and pitch and roll.

Algor has been developing FEA software since 1978.
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Engineered Bioremediation of Contaminated Soil

Electrokinetic transport is utilized to enhance biodegradation of contaminants by micro-organisms.

John F. Kennedy Space Center, Florida

Electrokinetically enhanced bioremediation (EEB) is a method of engineered bioremediation of soil contaminated by such organic compounds as solvents and petroleum products. As depicted schematically in the figure, EEB involves the utilization of controlled flows of liquids and gases into and out of the ground via wells, in conjunction with electrokinetic transport of matter through pores in the soil, to provide reagents and nutrients that enhance the natural degradation of contaminants by indigenous and/or introduced micro-organisms.

The operational parameters of an EEB setup can be tailored to obtain the desired flows of reagents and nutrients in variably textured and layered soils of variable hydraulic permeability and of moisture content that can range from saturation down to as little as about 7 percent. A major attractive feature of EEB is the ability to control the movements of charged anionic and cationic as well as noncharged chemical species.

The basic components of electrokinetic enhancement of bioremediation are the following:

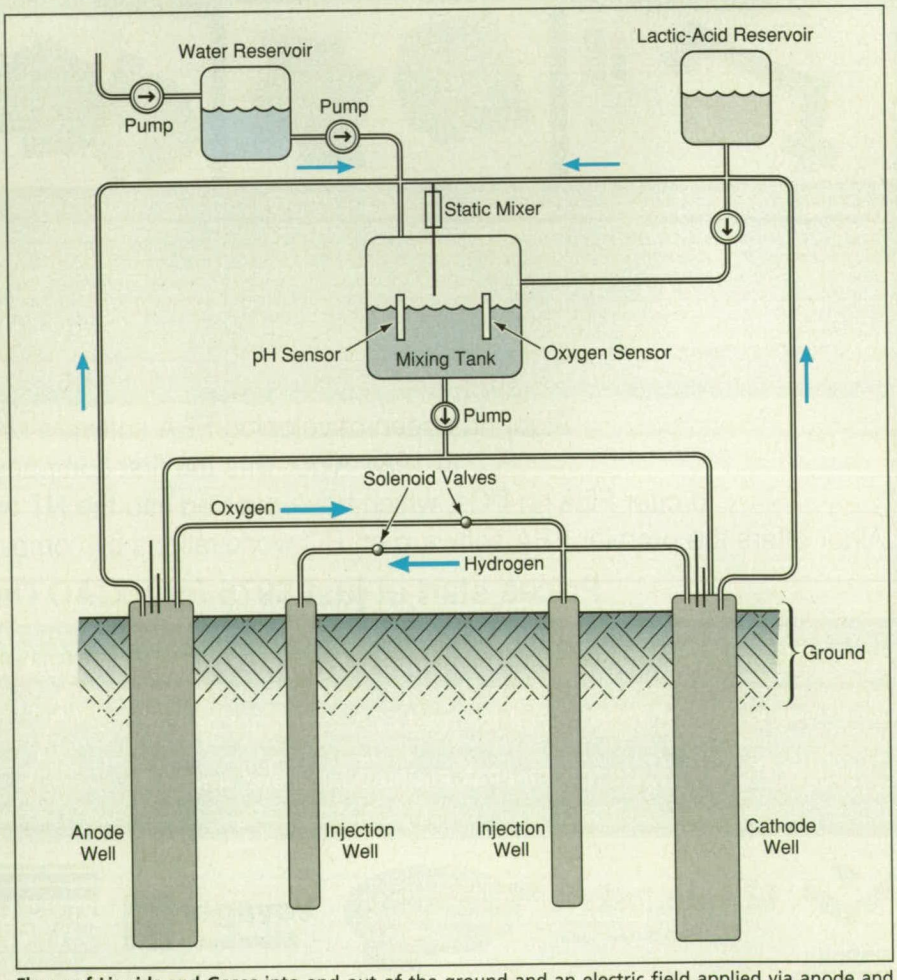
- Ions are transported by electromigration; that is, with minimum transport of liquid through the soil. The ions of interest include nutrient agents, electron donors (e.g., lactate) or electron acceptors (e.g., nitrate or sulfate) added to the soil. Electromigration is utilized as an efficient mode of electrokinetic transport in vadose-zone soils.
- Water in soil is pumped (horizontally or vertically, depending on the positions of electrode wells) by induced electro-osmotic flow. Whereas the hydraulic flow used in older methods decreases with decreasing pore size and is thus not effective for treating tightly packed soil, electro-osmotic flow is less restricted by tight packing. Electro-osmosis is utilized to enhance the transport of both ions and such noncharged particles as micro-organisms, by moving water from anodes (positive electrodes) toward cathodes (negative electrodes).
- Electrophoresis induced in soil under an applied electric field is used to control the transport and/or distribution of micro-organisms throughout the treated soil volume. The beneficial effect of electrophoresis can be augmented or otherwise modified by use of electro-osmotic flushing of the soil.
- The applied electric current can be utilized to heat the soil to the optimum temperature for bioremediation.
- The gaseous and liquid products of electrolysis of water in the soil are removed from electrode wells and mixed and reinjected into the ground as needed to maintain the pH of the soil within a range favorable for bioremediation.

This work was done by Dalibor Hodko, G. Duncan Hitchens, Tom D. Rogers, James W. Magnuson, and Jeffrey K. Dillon of Lynntech, Inc., for **Kennedy Space Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Bio-Medical category.*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

Lynntech, Inc.
7610 Eastman Drive, Suite 105
College Station , TX 77840

Refer to KSC-12045, volume and number of this NASA Tech Briefs *issue, and the page number.*



Flows of Liquids and Gases into and out of the ground and an electric field applied via anode and cathode wells are all controlled by a computer in response to sensed conditions and according to a schedule to generate conditions that favor *in situ* bioremediation of the soil.

Microgravity Tissue Engineering

Cartilage and cardiac muscle can be engineered for research in normal gravity and microgravity.

Lyndon B. Johnson Space Center, Houston, Texas

A continuing program of research and development focuses on engineering of functional cartilage and cardiac muscle for scientific research and for eventual use in transplants. The program involves the use of cells, polymer scaffolds, and bioreactor vessels. A polymer scaffold serves as a three-dimensional structure to which cells can attach. Once attached, the cells can regenerate full tissues, and then the polymer scaffold becomes biodegraded when no longer needed. A bioreactor provides an appropriate environment and physiological signals during the development of tissues.

Rotating bioreactors were originally developed by NASA to culture cells on Earth in environments that simulate some aspects of microgravity. In one bioreactor configuration, cells are cultured in an annular space between two cylinders that are rotated as a solid body. In the present program, bioreactors of this configuration were adapted for tissue engineering by adjusting the speed of rotation to maintain large tissues (disks 5 to 10 mm in diameter and 1 to 5 mm thick) freely suspended during culturing. Engineered cartilage capable of withstanding mechanical loading and engineered cardiac tissue that contracted in response to electrical stimulation were grown in these reactors.

The cartilage-tissue-engineering model system developed in this program was selected for the first long-term cell-culture study in outer space, using bioreactors developed by NASA that were both rotated and perfused aboard U.S. space shuttles (STS-79 and STS-81) and the *Mir* space station (September 1996 to January 1997). Tissue mass increased on *Mir* as well as in control specimens cultured on Earth, and the component cells remained alive and metabolically active. Specimens grown on Earth retained their initial discoid shape, contained high fractions of glycosaminoglycan [GAG (a key cartilage component)] and had high compressive stiffnesses. In contrast, constructs grown on *Mir* tended to be smaller, to be more nearly spherical, and to have lower GAG fractions and compressive stiffnesses. This study proved the feasibility of long-term cell culture in outer space, and provided a basis for further studies aimed at developing countermeasures for prolonged human spaceflight.

Rotating bioreactors also provide favorable environments for engineering tissues on Earth. Engineered cartilage cultured 6 weeks in rotating bioreactors has slightly higher cellularity, 68 percent as much GAG, 33 percent as much collagen type II, and 19 percent of the compressive stiffness of native cartilage. Composites based on engineered cartilage were recently used to resurface knee joints in adult rabbits. After 6 months, engineered cartilage was preserved at the joint surfaces, where it remodeled to the dimensions of the surrounding host cartilage. The subchondral tissue remodeled into mineralized trabecular bone.

Engineered cardiac tissue cultured for 1 week in rotating bioreactors was found to exhibit 26 percent of the cellularity, 90 percent of the conduction velocity, and 65 percent of the maximum capture rate of native neonatal heart tissue. Electrical impulses were found to propagate between extracellular electrodes spaced up to 5 mm apart in tissue up to 0.1 mm thick, and the engineered cardiac tissue could be stimulated to contract at desired frequencies ranging from 60 to 270 beats per minute. However, the dimensions and mechanical properties of engineered cardiac muscle do not yet favor the use of this tissue to repair damaged cardiac tissue in experimental animals.

This work was done by Robert Langer, Lisa E. Freed, and Gordana Vunjak-Novakovic of Massachusetts Institute of Technology for **Johnson Space Center.**

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

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E-mail: lfreed@mit.edu

Refer to MSC-22715, volume and number of this NASA Tech Briefs *issue, and the page number.*

New on the WEB

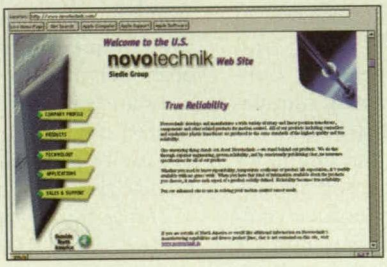
Motion Control

Nexen, Vadnais Heights, MN, offers a new site that provides product data and performance charts, an interactive product selection program, downloadable engineering drawings, parts lists, and user manuals. The company's brakes, clutches, servo motors, linear motion brakes, torque limiters, overload protection devices, and web tension control systems serve a variety of applications. **www.nexengroup.com**

Motor and Generator Protection

A new Web site from Meg-Alert, Minocqua, WI, highlights the company's Motor Guard and Gen Guard testing and protection systems designed to monitor and protect against winding insulation breakdown in electric motors and engine/generator sets. The site covers how to improve plant safety, prevent motor and generator failure, and how to incorporate motor and generator testing methods into a preventative maintenance program. **www.megalert.com**

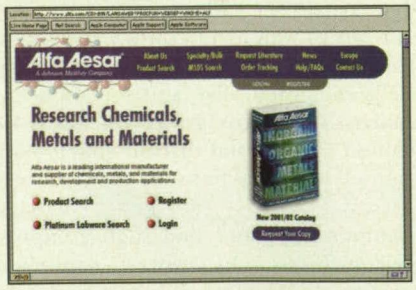
Position Sensors



Novotechnik U.S., Southborough, MA, has added specifications and drawings of its line of non-contacting, linear, and rotary position transducers on its Web site. The site includes product information and a technical overview of wear-free, non-contacting capacitive, and Indres® non-contacting inductive technologies. **www.novotechnik.com**

Chemicals, Metals, and Materials

Alfa Aesar, Ward Hill, MA, has revamped its Web site to include user access to product availability and current price status for the company's entire range of 25,000 research chemicals, metals, and materials. User profile data is retained, and order tracking has been added to allow customers to review all orders placed on the site. **www.alfa.com**



New on the MARKET

I/O Technology

ADLINK Technology, Irvine, CA, announces its open system I/O technology for high-speed, real-time control applications called High Speed Link (HSL). Current PC-based implementations of the technology use 6 Mbps transmission speeds and can scan 1000 I/O points per millisecond. Maximum scan rates of less than 2 milliseconds are sustained for 2,000 to 32,000 I/O points. The technology is based on an open standard, RS-422. I/O modules are hot swappable. **Circle No. 720**

Formed-In-Place Gaskets

Dymax Corp., Torrington, CT, offers the GA100 Series silicone-free formed-in-place (FIP) gaskets that cure in 5 to 30 seconds upon exposure to 365-nm wavelength ultraviolet light. The line is composed of five formulations with a range of properties, including adhesion to substrates, hardness, compression set, thermal range, water absorption, cure depth, and viscosity. Viscosities range from 450 to 60,000 cP and compression sets generally in the range of 5 to 10%. **Circle No. 721**

Recorder/Controller

The CT8100 circular chart recorder/controller from OMEGA Engineering, Stamford, CT, measures, displays, and controls up to two process variables. All recorder, control, and alarm functions are configured via a front keypad with self-prompting displays. Two user-configurable alarm settings are provided for each pen. The device features thermocouple, RTD, DC current, or voltage input. **Circle No. 723**

Processor Board

StorCase Technology, Fountain Valley, CA, offers the SAF-TE processor board, a field-upgradeable board designed for the InfoStation nine-bay backplane RAID enclosure. The processor board allows server administrators to monitor InfoStation environmentals including its four blowers, two power supplies, nine device slots, and 14 temperature sensors. Monitoring can either be done via the Web, using the included web-based management software SAFTEmon, or directly from the InfoStation's onboard user interface module. **Circle No. 724**

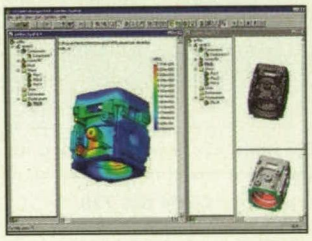
Proximity Sensor

Cherry Electrical Products, Pleasant Prairie, WI, has introduced the MP1021 Series solid-state magnetic proximity sensor for use in safety interlocks, end-of-travel sensing, and motor speed control. The digital Hall effect sensor allows the user to specify the sensing face. Electronics internal to the sensing module provide noise filtering and reverse battery protection. Supply voltage can range from 4.5 VDC to 24 VDC. It is available in a switching or latching configuration. **Circle No. 731**

New on DISK

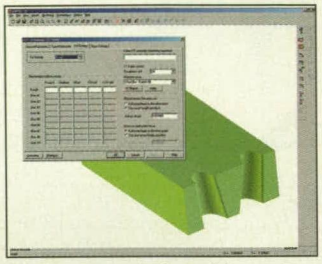
Analysis Software

Structural Research & Analysis Corp., Los Angeles, CA, has announced COSMOS/DesignSTAR 3.0 design analysis software, which offers full associativity with Autodesk Inventor, Solid Edge, and SolidWorks. In addition to basic stress, strain, displacement, frequency, buckling, and assembly analysis with gap/contact, the new version provides intermediate and advanced bundles for high-end users. These contain steady-state and transient thermal analyses, dynamic response, and fatigue. Enhancements include nonlinear capabilities, enhanced contact analysis, shell and contact stress analysis, faster solvers, reaction forces, fluid flow analysis, and motion simulation. **Circle No. 700**

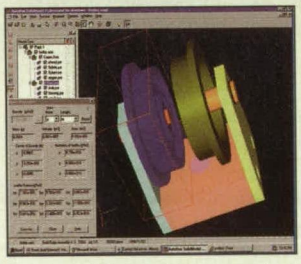


CAM Software for Wire EDM

ESPRIT/W Version 5.0 machining software for wire EDM machine tool programming is available from DP Technology, Camarillo, CA. It features enhanced knowledge based machining (KBM) tools for a variety of wire EDM machines. The software's automated cutting strategies include roughs-first, each cut, and per-cavity, which maximize unattended machine operation. Included in the software is a speed control bar, which allows users to manipulate the slider to move simulation speeds up and down in Windows NT/2000. **Circle No. 701**

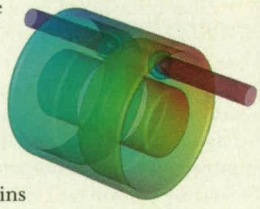


Visualization and Markup



Cimmetry Systems, Cambridge, MA, offers AutoVue 15.4 3D visualization and markup software that features markup/redlining capabilities, allowing users to create annotation files directly on a 3D model. Markup features include attaching text and sticky-notes to specific points on a model, and creating precise measurements of any dimension of the model. Once markups are created, they can be rotated with the model, remaining fixed to the designated anchor points. The software supports more than 200 different file formats and integrates with most PDM and document management systems. **Circle No. 702**

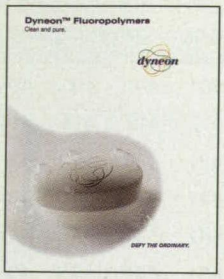
Chemical Engineering



FEMLAB Chemical Engineering software from COMSOL, Burlington, MA, features a model library with examples from the fields of chemical reaction engineering, electrochemical engineering, fluid dynamics in reactors and unit operation equipment, and heat balances in equipment for unit operations. It also contains ready-to-use predefined equations for momentum balances like Navier-Stokes equations, Darcy's Law, and Brinkman equations for porous media flow. The software runs under Windows 95/98/NT 4.0, and Macintosh System 7.1 or later. Installation of MATLAB® 5.3 or 6.0 is required. **Circle No. 703**

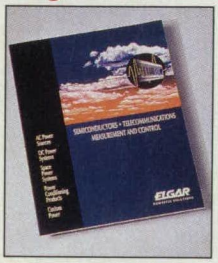
New LITERATURE

Fluoropolymers



Dyneon, Oakdale, MN, has released a brochure detailing fluoropolymers that offer low ion extractables, low permeation, thermal properties, low deformation under load, enhanced weldability, and the ability to use a variety of processing options to increase design opportunities. UHP series PFA resins and THP fluorothermoplastics are described. **Circle No. 706**

Programmable Power Supplies

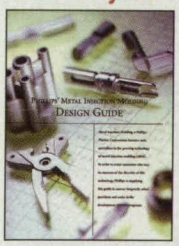


A 56-page product catalog from Elgar Electronics Corp., San Diego, CA, describes manual and programmable AC and DC power equipment for semiconductor, telecommunication, and measurement and control applications. Included are the ContinuousWave™ programmable AC power source series, SmartWave™ AC source series, custom OEM solutions, and a power rack integration service. **Circle No. 707**

Instrumentation Products

A 24-page catalog from APT Instruments, Litchfield, IL, highlights over 250 products such as miniature data loggers, wireless RF transmitters, small peristaltic pumps, and a range of portable instruments. Fourteen different product sections include instruments for refractive index, temperature, pH, relative humidity, sound level, and air velocity. **Circle No. 708**

Metal Injection Molding



Phillips Plastics Corp., Menomonie, WI, offers a design guide describing its Metal Injection Molding business unit. The guide assists in the development of metal injection molding (MIM) programs, including the benefits of MIM. It also provides a four-step process for producing MIM parts, as well as a the various materials and specifications needed for MIM. **Circle No. 709**

Automation Software

Beckhoff Automation, Minneapolis, MN, has released a brochure describing TwinCAT software, which turns any compatible PC into a real-time controller with a multi-PLC system, NC axis control, programming environment, and operating station. The software can replace PLC and NC controllers and operating devices with connection to common field buses and PC interfaces for I/O signals. **Circle No. 710**

Torque Sensors

Lebow Products, Troy, MI, offers a brochure on the Flange Dynamometer torque sensor designed for high-accuracy testing. The product eliminates bearings, slip rings, and other movable components. The single-piece rotary torque sensor is attached between the engine and load, while a non-contact telemetry antenna is pedestal-mounted around the sensor, transmitting a digital signal to the receiver unit. **Circle No. 711**

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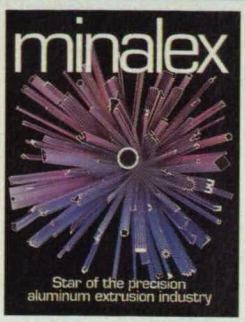

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New! An informative brochure from MINALEX, leader in close tolerance shapes to 3 1/2", illustrates typical applications and describes capabilities including short runs. MINALEX, quality leader, delivers on time, every time. MINALEX, PO Box 247, Whitehouse Station, NJ 08889; Tel: 908-534-4044; Fax: 908-534-6788.

Minalex

For More Information Circle No. 601

MINIATURE METAL BELLOWS

Servometer® miniature metal bellows for flexible seals, volume compensation, pressure responsive devices, EMI shields, vibration dampeners, etc. A 12-page Design Manual, containing detailed formulas for designing miniature nickel bellows plus parts which lend themselves to electroforming, is available from Servometer®. Typical applications for bellows are detailed. Engineering assistance available. Servometer® Precision Manufacturing Group, LLC, 501 Little Falls Road, Cedar Grove, NJ 07009-1291; Tel: 973-785-4630; Fax: 973-785-0756; website: www.servometer.com

Servometer®

For More Information Circle No. 602

NEW MID-RANGE HEATING/COOLING FLUID

New Paratherm MR™ heat/cool fluid is rated for optimal service from 30° F to 550° F. Designed for broad application including batch reactors, laminating lines and plastics mold temperature control, fluid is efficient across the temperature range, thermally stable and cost effective. Durable, it is safe and easy to handle, and provides extended performance under demanding conditions. The MR fluid is environmentally friendly. For a free engineering bulletin, call George Wilt, 610-941-4900 or write: Paratherm Corp., 1050 Colwell Rd., Conshohocken, PA 19428; website: www.paratherm.com

Paratherm Corporation

For More Information Circle No. 603

DATA ACQUISITION AND INSTRUMENTATION eCATALOG

This free 37-page short-form catalog from IOtech features product overview charts and selection guides for IOtech's wide range of data acquisition systems and signal conditioning options. New products include the ScanWare™ family of products for Ethernet-based data acquisition and a new multi-function, 8-channel counter/encoder module for the portable data acquisition systems. IOtech, Inc.; Tel: 440-439-4091; Fax: 440-439-4093; email: sales@iotech.com; website: www.iotech.com

IOtech, Inc.

For More Information Circle No. 604

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INSTRUPEDIA™

Instrupedia, the interactive encyclopedia of instrumentation, is a source of abundant information useful for building PC-based measurement and automation applications. This FREE CD includes the entire National Instruments product catalog, evaluation software, application notes, customer solutions, the searchable Knowledge Base, and more. Compatible with Windows 2000/NT/9x/3.1, and Mac OS systems, Instrupedia also provides links directly to the National Instruments Web site. National Instruments; Tel: 800-443-3488, 512-794-0100; Fax: 512-683-9300; email: info@ni.com; website: ni.com/info/instrupedia

National Instruments

For More Information Circle No. 606

2001 STOCK AND CUSTOM SPRINGS CATALOG

This 112-page catalog describes, with complete specifications, Lee Spring Company's full line of stock Compression, Extension and Torsion Springs; Spring Kits, Metric Springs, Hefty Die and Heavy Duty Springs and Belleville Washers including pricing for all stock springs in various quantities. Also included is a new Custom Springs section featuring specification forms for ordering a variety of custom springs. Lee Spring Company, 1462 62nd Street, Brooklyn, NY 11219; Tel: 718-236-2222; Fax: 718-236-4408; website: www.leespring.com

Lee Spring Company

For More Information Circle No. 607

FMEA SOFTWARE

Failure Modes and Effects Analysis using FMEA-Pro™ 5 empowers automotive, consumer, electronic, aerospace, defense and general manufacturing industries to improve the quality, reliability and safety of their products. This fully customizable, software helps companies comply with QS 9000, ISO 9000, SAE J1739, MIL-STD-1629, ISO/TS 16949 and other regulations. FMEA-Pro™ 5 contains extensive libraries and data protection features. The report generation tools support a variety of file formats, including HTML and PDF. Download a free trial: www.fmeasoftware.com.

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For More Information Circle No. 608

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PEM Fastening Systems

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INK CODE-MARKING MACHINES

Sprinter Marking, Inc. manufactures Sprinter™ automatic ink code-marking machines. Machines apply date codes, product codes, dots, etc. on metal, plastic, rubber, and paper surfaces. Marking possible in any orientation. Message size up to 2 square inches. Cycle speeds up to 350 CPM. A complete line of operating supplies and auxiliary equipment is offered. Sprinter Marking, Inc., 1805 Chandlersville Rd., Zanesville, OH 43701-4604; Tel: 740-453-1000; Fax: 740-453-6750; website: www.sprintermarking.com

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Workstations Give NASA Processing Power

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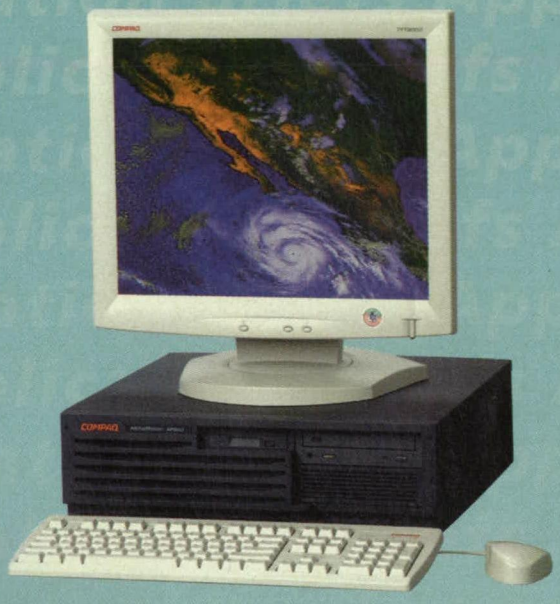
Under a $4.7 million contract through Lockheed Martin, Compaq is supplying 475 Alpha workstations and 635 color monitors to upgrade the Mission Control Centers at Johnson Space Center (JSC) for both the Space Shuttle and International Space Station (ISS). The systems will be used to monitor both ISS and shuttle flights.

When Lockheed Martin developed the control centers, they used commercial-off-the-shelf (COTS) products. According to Jay Honeycutt, president of Lockheed Martin Space Operations, "we have another benefit to the COTS approach, because we can go out into the commercial market to upgrade the systems, providing NASA with a significant increase in functionality at a fairly modest cost."

Some of the Alpha workstations currently in use in the control center date back to 1993.

Since that time, new software has been added to the systems to automate many new tasks, said Jack Knight, chief of NASA's Advanced Operations and Development Division at JSC. This put a strain on the old systems. While they can still do the job, the old systems had much longer processing times.



As part of its contract with NASA, Lockheed Martin assumed responsibility to replace non-maintainable NASA equipment. Installation of the Compaq workstations will be accomplished in four phases on an accelerated schedule. In the first phase, which began in March, 129 workstations will be installed. The entire upgrade is expected to be complete by September.

For More Information Circle No. 750

Software Checks NASA Contractor Code

Visual FlowCoder software analysis tool
FlowLynx
Huntsville, AL
256-704-7850
www.flowlynx.com

NASA's Marshall Space Flight Center in Huntsville, AL, is using Visual FlowCoder to check the work of contractors creating software code for satellite and rocket engine control. The software graphically maps the flow of software code, displaying procedures, functions, and other routines in a visual format based on the code's algorithmic flow. Users can visually see the steps in a program to aid code development, maintenance, bug-fixing, and documentation. Marshall engineers are using the software to analyze engine control software for the MC1 engine on the X34 reusable launch vehicle project. It will help to integrate C code and Ada code.

NASA Marshall's Avionics Department owns five FlowCoder licenses. It is also being used as the core of a software module that will verify that the department's code meets standards. "It serves as a second pair of eyes," said Luis Trevino, team lead of the software design group in the Avionics Department. "Indirectly, it was used to force [contractors] to do a good job on the code."

Pat Benson, a Marshall computer engineer, used FlowCoder to analyze software for flight control of the Chandra satellite. Software engineers from TRW wrote much of the Chandra avionics code in C and Ada. NASA Marshall also plans to use the tool while creating software for the X-Ray satellite project.

For More Information Circle No. 751

pumping *plastic*

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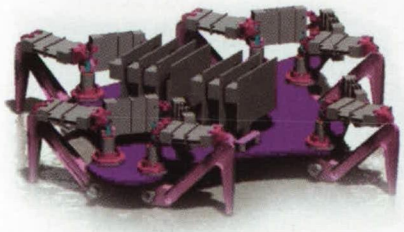

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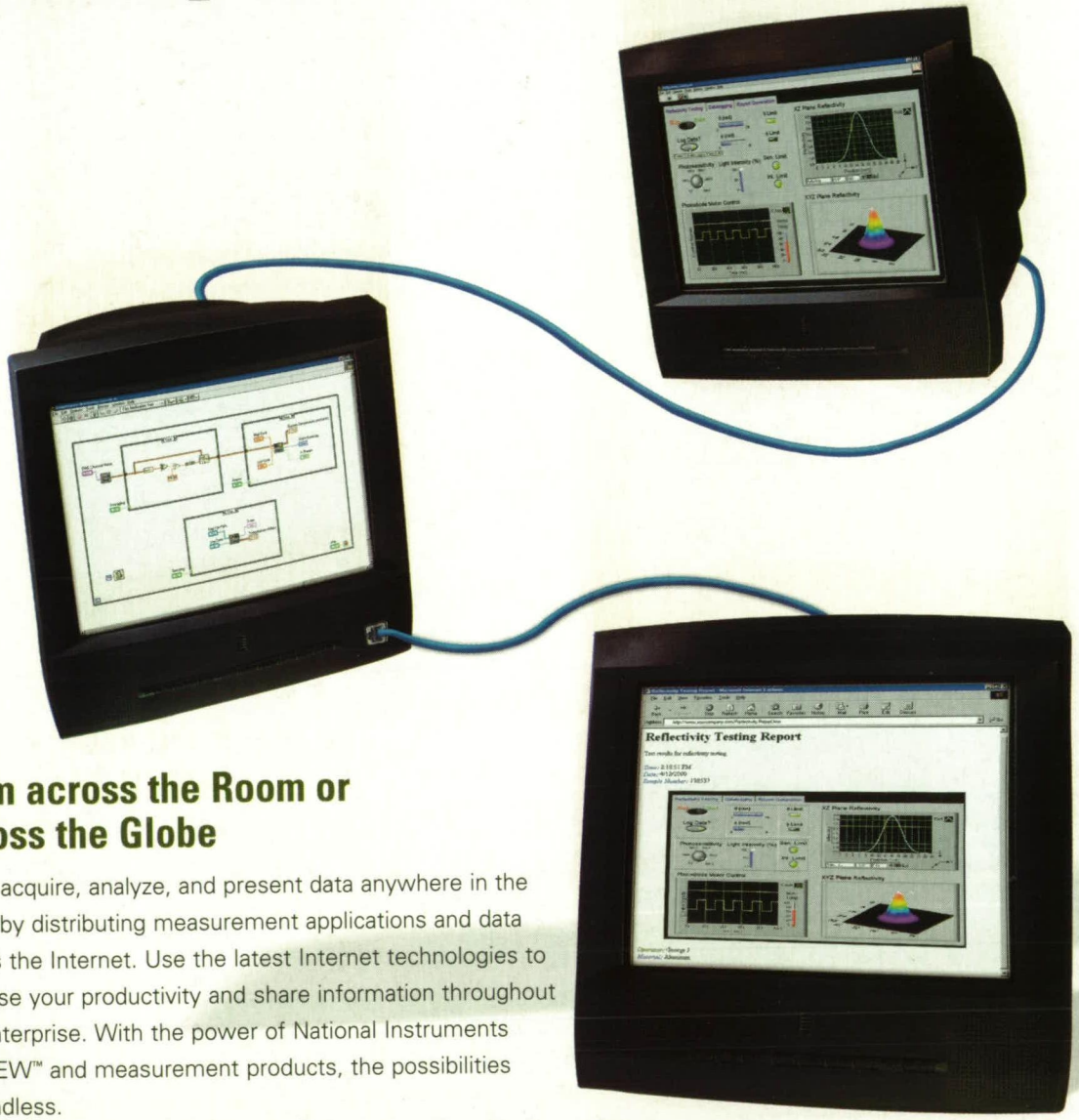

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